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ENVIRONMENTAL PROTECTION AGENCY
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EVALUATION OF SEWAGE TREATMENT FACILITIES
San Francisco, California
September 1975

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER - Denver, Colorado
and
REGION IX - San Francisco, California

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I. INTRODUCTION

On 8 December 1975, the California Regional Water Quality Control Board plans to conduct a hearing at which evidence of noncompliance with time schedules and violations of effluent and receiving water limitations or standards will be presented.

At the request of EPA Region IX, the National Enforcement Investigations Center (NEIC) conducted studies from 12-26 September 1975 of the Richmond-Sunset, North Point and Southeast Water Pollution Control Plants of the City and County of San Francisco.

Investigations conducted by the NEIC were designed to meet the following objectives:

1. To determine compliance with NPDES permit discharge limitations of the North Point, Richmond-Sunset, and Southeast wastewater treatment plants of the City and County of San Francisco.

2. To determine if waste discharges from San Francisco wastewater treatment plants are causing violations of established receiving water limitations, water quality standards, and beneficial uses of San Francisco Bay and the Pacific Ocean.

3. To evaluate alternative, interim (prior to construction of secondary facilities) pollution control measures for the North Point, Richmond-Sunset and Southeast wastewater plants.

II. SUMMARY AND CONCLUSIONS

At the request of EPA Region IX, the National Enforcement Investigations Center conducted a survey in September 1975 of the San Francisco sewage treatment facilities. The principal purposes of this investigation were to determine the plant efficiencies, compliance with NPDES permit conditions, and the environmental impact of wastewater discharges upon the shoreline waters of San Francisco, California.

RICHMOND-SUNSET PLANT

1. The in-plant survey of the Richmond-Sunset Water Pollution Control Plant was conducted 17-19 September 1975. Suspended solids removal efficiencies were calculated to be 56, 87 and 88%, with an average of 77%. This degree of efficiency is higher than is normally expected of a primary treatment plant. Because of the limited solids-handling capability, which precludes the addition of chemicals, there is no low-cost revision to operating or maintenance procedures that would significantly improve solids removal efficiency.

2. Results of the in-plant survey showed that the plant was in compliance with the NPDES permit limitations for pH (6.0 to 9.0) and settleable solids (daily average <0.5 ml/l; daily maximum <1.0 ml/l). It is expected that the plant will violate the effluent settleable matter limitations during periods of maximum peak dry weather flow and during wet weather. This will be particularly true when one or more of the final sedimentation tanks is out of service.

3. Chlorine concentrations in the plant effluent ranged from 4.3 to 8.4 mg/l. The proposed residual chlorine permit limitation, which is not currently in effect, is an instantaneous maximum of 0.0 mg/l.

4. Pathogenic *Salmonella enteritidis* ser Agona were isolated from the plant effluent. The discharge of these disease-producing microorganisms creates a nuisance which is prohibited by the California Water Code. Increased chlorine contact time would reduce the discharge of these pathogens into the receiving waters; also residual chlorine concentrations would be reduced.

5. Bioassays revealed that the plant effluent was acutely toxic to threespine stickleback. The LC50 calculated from 96-hour static bioassays ranged from 21 to 30.5 %. The discharge of toxic substances from the Richmond-Sunset plant was a violation of the California Water Quality Control Plan.

6. Water quality investigations at the Richmond-Sunset plant outfall and along the waterfront from Ocean Beach to Baker Beach were conducted 15-24 September 1975. Physical and chemical analyses of the water samples showed that offshore stations south of the Richmond-Sunset plant outfall were characteristically marine. Northeast of the outfall, the water chemistry and physical characteristics reflected estuarine conditions of higher water temperatures with lower salinity and pH levels. The trend from marine to estuarine conditions appeared to be influenced by both the discharge from the Richmond-Sunset plant and ebbing from San Francisco Bay.

7. Receiving water at Stations 31, 33 and 35, immediately offshore from the plant outfall, contained 0.01 mg/l of dissolved sulfide. The receiving water requirement of the NPDES

permit that limits dissolved sulfide to less than 0.1 mg/l was not violated.

8. Measurable amounts (>1.0 mg/l) of chlorine were found at Stations 31 and 33 during the 10-day September survey. Residual chlorine in the receiving waters as low as 0.05 mg/l has been found to be toxic to aquatic organisms.

9 *Salmonella*, a disease-producing microorganism, was isolated from receiving water samples collected at the plant outfall (Station 30) and along the waterfront at Ocean Beach (Station 47). Presence of these pathogenic bacteria demonstrates contamination of the receiving water by fecal material; this degradation of bacterial water quality is a violation of the California Water Quality Control Plan. Additionally, these organisms create a nuisance which is a violation of the California Water Code.

10. A fecal coliform bacterial density of 540/100 ml recorded at Station 43 was in violation of the State Water Quality Control Plan limiting fecal coliform bacteria to an instantaneous maximum of 400/100 ml. Total and fecal coliform bacteria densities at Stations 45 and 47, near Ocean Beach, also exceeded the California Water Quality Control Plan requirements (<240 total coliforms/100 ml and <50 fecal coliforms/100 ml, median densities).

11. The California Water Quality Control Board has officially recognized shellfish harvesting as a beneficial use of ocean shoreline waters; however, the Richmond-Sunset outfall area has not been designated as a shellfish harvesting area by the Board. All sampling stations adjacent to the Richmond-Sunset plant outfall, except Station 39 off Baker Beach, were in

excess of the U. S. Public Health Service Bacteriological Standards for Shellfish Harvesting Waters (median total coliform density of <70/100 ml; and not more than 10% of samples shall exceed 230/100 ml).

12. In situ tests indicated some impairment to the quality of the oysters that were exposed in the Pacific Ocean near the Richmond-Sunset plant outfall. Some of the surviving yearling oysters exposed 5-1/2 days at Station B1 were putrid smelling. When shucked, the oyster tissues from these shellfish were found to be unusually mucous. The tests also showed 18% mortality of seed oysters exposed at Station B1. The discharge of substances which are toxic or deleterious to marine life is a violation of the California Water Quality Control Plan.

13. Inspection of littoral and intertidal areas near the plant outfall revealed substantial differences in the biological community, but no sludge deposits. The intertidal zone within 50 m of the outfall contained no living algae or invertebrates. The zone 50-100 m (160-330 ft) northeast of the outfall supported a few midge larvae. Water quality improved in the area 100-200 m (330-660 ft) northeast of the outfall as shown by the increased diversity of organisms; this intertidal zone was inhabitated by algae, midge larvae, beach hoppers, barnacles, limpets and other gastropods. At 200-400 m (660-1,300 ft) northeast of the outfall, a typical marine biota was found in the intertidal area including shrimp, polychaetes, limpets, starfish, clams, barnacles, and sponges. Degradation of the biological community in the vicinity of the Richmond-Sunset outfall is a violation of the California Water Quality Control Plan.

NORTH POINT PLANT

1. The in-plant survey of the North Point plant was conducted 17-19 September 1975. Suspended solids removal efficiencies were 77, 82, and 91%, and averaged 83%. An increase in the ferric chloride addition rate (to 150 mg/l as $FeCl_3$ or to the maximum that can be handled by the sludge removal system) could improve removal efficiencies.

2. The settleable solids concentrations in the plant effluent were within prescribed limitations on 17-19 September 1975.

3. The pH values of half of the effluent samples ranged from 6.1 to 6.4 and were in violation of the 6.5 unit lower limit required in NPDES Permit No. CA0037877 and of the California Water Quality Control Plan. Because no large industry is involved, it is probable that the addition of chlorine and ferric chloride caused the pH violations.

4. Iron analyses of wastewater samples collected before and after ferric chloride addition showed that the control of the chemical addition rate was poor. Improved control of the chemical addition rate would increase suspended solids removal efficiency.

5. Residual chlorine concentrations in the effluent ranged from 0.1 to 5.7 mg/l. The presence of residual chlorine in the effluent after 5 October 1975 would constitute a violation of NPDES permit limitations (0.0 mg/l).

6. The geometric mean number of fecal coliform bacteria in the effluent was 770,000/100 ml for 10 consecutive days, far in excess of the permit limitation of 400/100 ml for 7 consecutive

days. Two violations of the limitation restricting total coliform bacteria to <240/100 ml in five consecutive samples occurred. Nine violations occurred for single samples containing total coliform bacteria in excess of 10,000/100 ml. Increased chlorine contact time would decrease the amount of bacterial contamination discharged to the receiving waters; also, residual chlorine concentrations would be reduced. The reduced amount of chlorine that would be required if increased contact time is provided would have the additional benefit of reducing pH violations.

7. Pathogenic *Salmonella enteritidis* ser Anatum and *S. enteritidis* ser Senftenberg were isolated from the effluent. These disease-producing microorganisms constitute a nuisance which is prohibited by the California Water Code.

8. Bioassays demonstrated that the North Point effluent was acutely toxic to threespine stickleback. The LC50 calculated from 96-hour static bioassays ranged from 48 to 68% and averaged 59%. This toxicity was a violation of the NPDES permit and California Water Quality Control Plan limitations prohibiting the introduction of "toxic or other deleterious substances" into receiving waters.

9. Surface temperatures, pH and salinities clearly demonstrated the influence of the North Point discharge upon San Francisco Bay. Surface temperatures decreased from 16.3 to 15.5°C (61.3 to 59.9°F) in an outwardly direction from the discharge while salinities and pH increased. The increase in pH values on 16, 17 and 18 September exceeded the NPDES Permit No. CA0037877 and California Water Quality Control Plan receiving water

limitation of 0.2 pH unit variation. Dissolved oxygen concentrations were lower at points near the outfalls than at points farther out into the Bay, but were not in violation of permit limitations. The minimum dissolved oxygen recorded during the survey was 5.0 mg/l near Pier 35 on 15 September 1975.

10. Residual chlorine (~1.0 mg/l) was measured at Stations 13, 15, 21, 23 and 25. Residual chlorine in the receiving waters as low as 0.06 mg/l has been found to be toxic to aquatic organisms.

11. Although the limitation of 0.1 mg/l dissolved sulfide was not equaled or exceeded, sulfide concentrations approaching the limitation were measured at several locations near the North Point discharge.

12. Fecal coliform bacteria median densities at Stations 13, 15, and 25 near the plant discharges ranged from 2 to >2400/100 ml and exceeded the limitation 400/100 ml of the California Water Quality Control Plan. Total coliform densities at Stations 13, 15, 17, 21 and 23 ranged from 5 to 9,200/100 ml and were in excess of the U. S. Public Health Service Standards for Shellfish Harvesting Waters (<70/100 ml, median density; nor shall more than 10% of samples exceed 230/100 ml). The California Regional Water Quality Control Board has officially recognized shellfish harvesting as a beneficial use of San Francisco Bay; however, the North Point outfall area has not been designated as a shellfish harvesting area by the Water Quality Board.

13. Extensive mortality occurred among oysters exposed *in situ* for 5-1/2 days near the North Point discharges. Mortality of seed oysters was 22% at Pier 33 and 13% at Pier 35 (average 28%);

among juvenile oysters 14% mortality occurred at Pier 33 and all yearling oysters survived at Pier 35. Some of the surviving juvenile oyster tissues from the Pier 33 exposure were unusually mucous and putrid smelling. The discharge of substances which are toxic or deleterious to marine life is a violation of NPDES Permit No. CA0037672, and the California Water Quality Control Plan.

14. Benthic communities were influenced by the North Point discharges. The NPDES Permit No. CA0037672 and the Water Quality Control Plan specifically prohibit the deposition of bottom deposits and the discharge of toxic or deleterious substances causing degradation of benthic communities. A sludge deposit was found to extend approximately 200 m (660 ft) from Pier 33 to Pier 31. Nearly 21,000 benthic organisms per square meter, dominated by pollution-tolerant scuds, polychaetes, and nematodes, inhabited the sludge bed. In the area from Pier 29 to Pier 39 but outside the sludge bank, benthic communities were also dominated by pollution-tolerant scuds and polychaete worms but in lower densities. At Stations 18 and 26, outside the zone of direct influence from the North Point discharges, water quality conditions improved; pollution-sensitive barnacles were the dominant benthic macroinvertebrates.

SOUTHEAST PLANT

1. The in-plant survey of the Southeast Water Pollution Control Plant was conducted 17-18 September 1975. Efficiencies of the treatment plant in removal of suspended solids were calculated to be 87, 84 and 93% with an average of 88%. Modifications in the control of the chemical feed rate are necessary for sustained high solids removal efficiency. An increase in the

ferric chloride addition rate (to 150 mg/l as $FeCl_3$ or to the maximum that can be handled by the sludge removal system) would improve removal efficiencies.

2. Surges of industrial wastes in the plant influent were reported to interfere with the coagulation effect of the chemicals being added, thus reducing the plant efficiency. Minimization of these changes in influent characteristics by equalization or pretreatment of the industrial wastes would reduce the frequency of plant upsets.

3. The return stream from sludge handling operations contributes 10-25% of the total suspended solids entering the sedimentation tanks. This return stream is presently introduced into the main flow downstream from the point of chemical addition. Return of this flow from sludge handling upstream of the point of chemical addition would increase the effect of the chemicals, thus reducing the suspended solids content of the effluent.

4. Results of the in-plant survey showed that the plant was in compliance with the NPDES permit limitations for pH (6.0-9.0) and settleable solids (daily average -0.5 ml/l; daily maximum -1.0 ml/l).

5. During the September 1975 survey, chlorine concentrations in the plant effluent ranged from 3.1 to 7.2 mg/l. The proposed residual chlorine permit limitation, which is not currently in effect, is an instantaneous maximum of 0.0 mg/l.

6. Total coliform bacteria densities in the effluent were continually in excess of the NPDES median limit of 240/100 ml. Additionally, four violations occurred for the single sample maximum limit of 10,000 total coliforms/100 ml. These violations

were verified by repeat samples collected within 48 hours. Increased chlorine contact time would decrease the amount of bacterial contamination discharged into the receiving water; also, residual chlorine concentrations would be reduced.

7. Pathogenic *Salmonella enteritidis* ser Derby were isolated from the plant effluent. The discharge of these disease-producing organisms creates a nuisance which is prohibited by the California Water Code.

8. The chlorinated effluent from the Southeast plant was acutely toxic to threespine stickleback. Bioassays showed the effluent dramatically changed from day to day. The LC50 values ranged from 17 to 78% and averaged 38%. The discharge of "toxic or deleterious substances" is a violation of the NPDES permit and the California Water Quality Control Plan.

9. The Southeast plant effluent caused minor changes in the water temperature, DO, pH and salinity in San Francisco Bay. Transparency measurements indicated the presence of the Southeast plant effluent. The background station in the Bay had an average transparency of 1.9 m (6.2 ft). Transparencies decreased moderately at stations influenced by the discharge (1.4 to 1.5 m; 4.6 to 4.9 ft).

10. Receiving waters near the Southeast plant discharge contained 0.01 to 0.07 mg/l of dissolved sulfide. The NPDES permit limitation for dissolved sulfide (<0.1 mg/l) was not violated.

11. Daily monitoring of receiving waters near the Southeast plant discharge (Stations 4 and 5) showed measurable amounts of chlorine (<1.0 mg/l). Residual chlorine in the receiving waters as low as 0.06 mg/l has been reported to be toxic to aquatic organisms.

12. At Station 5, located within the influence of the Southeast plant discharge, a violation of the Bacteriological Standards of California Water Quality Control Plan occurred. The Plan states that "no single sample shall exceed 400 fecal coliforms/100 ml." At Station 5, fecal coliform bacteria ranged from <2 to 920/100 ml with one sample exceeding the 400 fecal coliform/100 ml limitation. Additionally, receiving waters within the influence of the plant effluent were in violation of the U. S. Public Health Service Bacteriological Standards for Shellfish Harvesting. The California Water Quality Control Board has officially recognized shellfish harvesting as a beneficial use of San Francisco Bay; however, the Southeast plant outfall area has not been designated as a shellfish harvesting area by the Water Quality Board.

13. Extensive mortality occurred among oysters exposed in situ for 5-1/2 days near the Southeast plant discharge. Mortality of seed oysters at exposure sites ranged from 7 to 58% with an average of 27%. Mortality of yearling oysters averaged 5%. Examination of the surviving juvenile oysters showed that some of the tissues were unusually mucous and putrid smelling. The discharge of substances which are toxic or deleterious to marine life is a violation of the NPDES Permit and the California Water Quality Control Plan.

14. Benthic populations were influenced by the Southeast plant discharge. The NPDES Permit No. CA0037664 and the California Water Quality Control Plan specifically prohibit the deposition of bottom deposits. A sludge deposit at least 60 m (66 yd) wide extended along the Southeast plant outfall diffuser. Benthic invertebrate communities inhabiting all of the areas in the vicinity of the discharge were characteristic of soft,

organically rich substrates; scuds and polychaete worms were extremely numerous (2,029-46,962/m^2) and clams, Cumacea and cockles were abundant. In the sandy bottom outside the area of influence of the plant discharge, benthos consisted of polychaete worms, clams and amphipods in low numbers.

III. DESCRIPTION OF THE STUDY AREA

The Richmond-Sunset, North Point and Southeast Water Pollution Control Plants collect and treat sewage from the city of San Francisco. Each of these primary plants serves a major section of the City (Fig. 1). Studies described in this report were limited to evaluating the three treatment plants, their effluents, and the quality of receiving waters.

In-plant sampling stations were established at the influent and effluent pipes and at other selected locations in each plant. Wastewater samples were collected from these sites and analyzed for the parameters shown in Table 1.

Receiving water sampling stations were established in the immediate vicinity (within 1,500 m; 5,000 ft) of wastewater discharges from the North Point and the Southeast plants and along the waterfront near the Richmond-Sunset plant from Baker Beach to Ocean Beach (Fig. 1). In these study areas the receiving water was analyzed for dissolved oxygen, pH, temperature, dissolved sulfide, residual chlorine, transparency, salinity, bacterial contamination and toxicity (Table 1). Additionally, benthic biota and sediment were collected from selected stations and examined to determine the environmental impact of wastewater discharged from the three San Francisco sewage treatment plants.

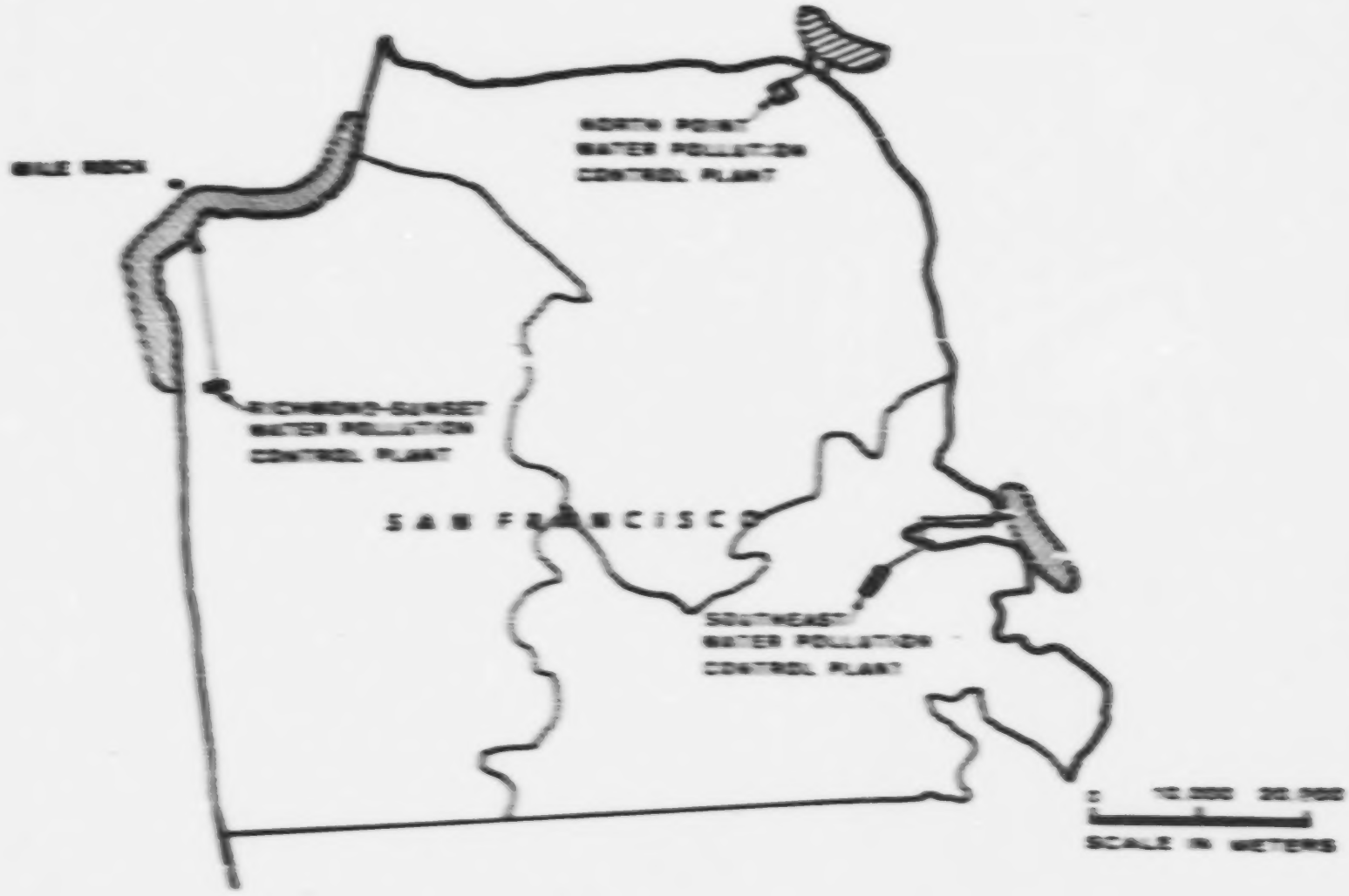

Figure 1. San Francisco Sewerage System, Treatment Facilities and Sampling Areas

IV. WATER QUALITY CRITERIA

BENEFICIAL USES

The California Regional Water Quality Control Board, San Francisco Bay Region, has the responsibility for protection of beneficial uses of the Bay and ocean adjacent to San Francisco. The Water Quality Control Board has declared its intention to preserve the beneficial uses summarized below:

1. Recreation
2. Industrial water supply
3. Fishing and fish propagation (including shellfish and other aquatic resources)
4. Wildlife habitat
5. Navigation
6. Aesthetic enjoyment

To protect these beneficial uses, the Board has at least two means of enforcement: the National Pollutant Discharge Elimination System (NPDES) and the California Water Quality Control Plan.[1]

NPDES PERMITS

Effluent limitations effective during this study are found in NPDES Permit Nos. CA0037681 (Richmond-Sunset plant), CA0037672 (North Point plant), and CA0037664 (Southeast plant) issued by the California Regional Water Quality Control Board. The effective limitations are tabulated on the following page.

| | | |

Also, each permit stipulates that no violations of the California Water Quality Control Plan shall occur.

WATER QUALITY CONTROL PLAN

Most of the provisions in the California Water Quality Control Plan have been considered in the NPDES permits for each particular discharge. Applicable California Water Quality Control Plan provisions are summarized below.

pH - (for Bay waters) - shall not be depressed below 6.5 nor raised above 8.5; ±0.2 units variation.

- (for ocean waters) - shall not be depressed below 7.0 nor raised above 8.5.

Dissolved Oxygen - (for Bay waters) - ≥5.0 mg/l

- (for ocean waters) - Mean annual DO shall not be less than 6.0 mg/l; minimum DO shall not be less than 5.0 mg/l at any time.

Color - Discharge shall be free of coloration that causes nuisances or adversely affects beneficial uses.

Tastes and Odors - There shall be no taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin that cause nuisances or adversely affect beneficial uses.

Floating Material - Discharge shall not contain floating material, including solids, liquids, foams, and scum in concentrations that cause nuisances or adversely affect beneficial uses.

Suspended Material - Discharge shall not contain suspended material in concentrations that cause nuisances or adversely affect beneficial uses.

Settleable Material - Discharge shall not contain settleable material in concentrations that cause nuisances or adversely affect beneficial uses.

Oil and Grease - Discharge shall not contain oils, greases, waxes or other materials in concentrations that result in a visible film or coating on the water or on objects in the water that cause nuisances or adversely affect beneficial uses.

Biostimulatory Substances - Discharge shall not contain biostimulatory substances in concentrations that promote aquatic growth to be a nuisance or affect beneficial uses.

Sediment - The sediment load and discharge rate of surface water shall not be altered so as to cause nuisances or affect beneficial uses.

Turbidity - Discharge shall be free of changes in turbidity that cause nuisances or affect beneficial uses.

Bacteria (Contact Recreation including ocean areas) - ≤240/100 ml total coliforms, median of 5 samples; ≤10,000/100 ml, any one sample; ≤50/100 ml fecal coliforms, median of 5 samples; ≤400/100 ml, any one sample.

Bacteria (Shellfish harvesting) - <70/100 ml total coliforms, monthly median; not to exceed #30/100 ml in 10% of samples collected.

Temperature - shall not be altered unless temperature does not affect beneficial uses; <5° above natural conditions.

Toxicity - Water shall be maintained free of toxic substances that affect humans, plants, animals or aquatic life.

Pesticides - shall not be present in concentrations that adversely affect bottom sediments, surface waters or aquatic life.

Sulfides - All waters shall be free of dissolved sulfides concentration above natural background levels.

Additional limitations have been determined specifically for metals concentrations, individual pesticides and herbicides. These relate to adverse effects upon the beneficial uses also.

V. STUDY FINDINGS

RICHMOND-SUNSET PLANT

In-Plant Survey

Operation and Efficiency

The Richmond-Sunset plant is located in the southwest corner of Golden Gate Park on South Drive opposite 48th Avenue. Built in 1938, the plant has a design peak flow rate of 397,400 m^3/day (105 mgd). At this flow rate, 265,000 m^3/day (70 mgd) receives complete primary treatment and 132,500 m^3/day (35 mgd) is screened and chlorinated before discharge. The normal dry weather flow to the plant is about 75,700 m^3/day (20 mgd). Figure 2, a flow diagram of this plant, shows the sampling stations used during the survey.

The plant serves an area of 4,600 ha (11,300 acres) west of the Twin Peaks-Mt. Davidson line with an estimated contributory population of 230,000. It provides conventional primary treatment including pre-screening, grit removal, sedimentation and post chlorination. Chemical addition facilities have been provided at the plant but were not in use at the time of the survey. The effluent is discharged into the Pacific Ocean at an outfall near the beach at Land's End about 0.4 m (1.3 ft) below mean lower low water. The grit and screenings are hauled by truck to a sanitary landfill. During wet weather conditions the ocean outfall also carries untreated storm water and sanitary wastes from combined sewers within the Richmond-Sunset drainage area.

Solids handling processes for the Richmond-Sunset plant include thickening, anaerobic digestion, elutriation and vacuum filtration. The resulting sludge cake is used as a soil conditioner in the City parks and is available to the general public.

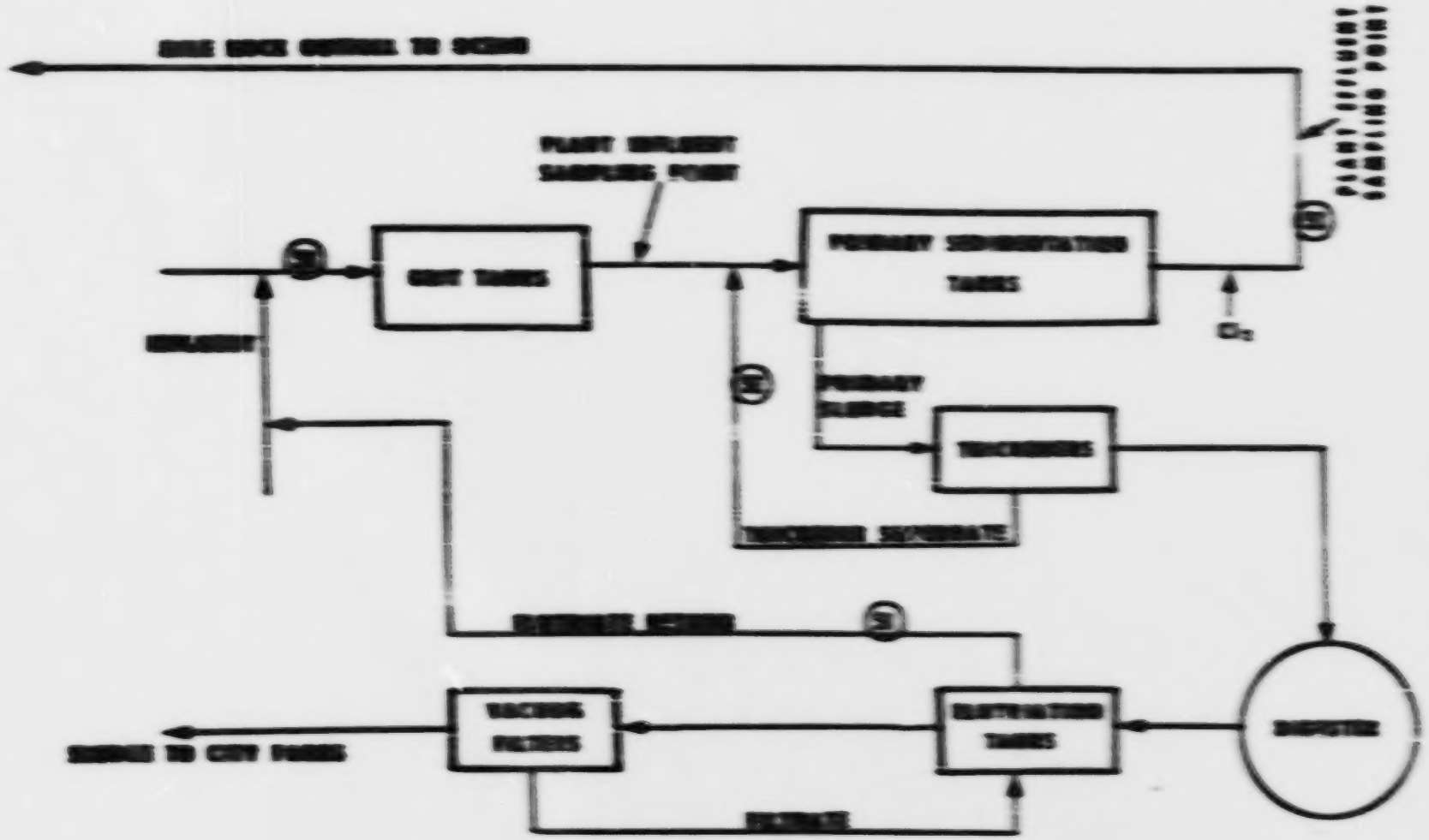

Figure 2. Flow Diagram and Sampling Locations, Richmond-Sunset Plant

City and County of San Francisco

Pumping of the thickening tank supernatant to the head of the plant is a batch operation governed by the level in the thickening tank. Supernatant pumping periods vary in frequency and duration according to the amount of sludge and operator judgement. Details of the plant facilities are well documented in a recent report by CH$_2$M Hill.[3]

Plant efficiency was evaluated during the inplant survey conducted in September 1975. Sampling locations and schedules were designed to evaluate the efficiency of suspended solids removal and the degree of compliance with effluent limitations (table 1). Details of this sampling design and associated methodology are presented in Appendix B.

The Richmond-Sunset sewage treatment plant achieved solids removals of 56, 87 and 88% on 17, 18 and 19 September, respectively (table 2). The 56% represents average removal for a plant of this type. The 87 and 88% are unusually high for a primary plant not using chemical treatment. They exceed the EPA suspended solids removal criteria of 85% for secondary treatment.

During the three days of the in-plant survey, the suspended solids removal efficiencies reported in the self-monitoring data were 53.1, 79.5 and 54.8% for an average of 63%. These figures do not agree with the survey findings of 56, 87 and 88% (avg., 77%) on the same dates. In part, the discrepancy occurred because the influent sample obtained by plant personnel was collected downstream from the grit removal tank (Fig. 2), while influent samples obtained by survey personnel were collected upstream of the grit tanks. The influent sample should be collected before any treatment occurs.

Table 3 shows the self-monitoring data on the Richmond-Sunset plant from January to September 1975. The daily suspended solids removals ranged from 0 to 92% during that period. Some of the low readings may be the result of excessive flow caused by rain. These figures emphasize the desirability of providing adequate facilities to handle wet weather flows.

Analysis of the samples taken during this survey showed that the solids recycled in the elutriate and supernatant contributed 9, 8 and 14% of the total suspended solids entering the sedimentation tanks on 17, 18 and 19 September respectively. The daily composite suspended solids concentration of the supernatant ranged from 710 to 2,000 mg/l and that of the elutriate from 310 to 1,400 mg/l. These are not excessive contributions for recycle streams.

With respect to solids removal, the Richmond-Sunset plant is at present doing all that can be expected of a primary plant. A recent study by CH$_2$M Hill[3] disclosed that the sludge handling capabilities of the plant are limiting. When these capabilities are increased, chemical addition may be used to increase the removal of suspended and settleable solids. This revision would probably enable the plant to increase its load without violating effluent limitations.

Effluent Quality

Physical-Chemical Characteristics. Settleable solids discharged by the Richmond-Sunset plant were found to be in compliance with NPDES Permit No. CA0037681 which limits settleable matter to a single sample maximum of 1.0 ml/l and a daily composite value of 0.5 ml/l. The in-plant survey revealed that a maximum of 0.6 ml/l settleable solids was discharged on 17 September 1975. Although a flow-proportional composite was not collected for settleable matter, the arithmetic average of the six samples collected each day was 0.25, 0.23 and 0.13 ml/l for 17, 18 and 19 September, respectively.

The previously referenced report by CH$_2$M Hill stated that, at a total flow rate of 170,300 m^3/day (45 mgd), the plant would probably exceed the limitation of 0.5 ml/l of settleable matter on a 24-hour composite sample. It also stated that at an instantaneous flow rate of 180,900 m^3/day (47.5 mgd) the grab sample limitation of 1.0 ml/l of settleable matter would be violated.

Historical data from plant records show that in the 1972-73 reporting period the maximum dry weather flow was 87,100 m^3/day (23 mgd). During the survey period, it can be determined that the maximum dry weather flow encountered in the 1972-73 period was 23 x 1.5, or 130,600 m^3/day (34.5 mgd). CH$_2$M Hill reported that the peak dry weather flow is 147,600 m^3/day (39 mgd).

Assuming that all five of the sedimentation tanks are on-stream, the data indicate that it is unlikely that the settleable matter limitation will be violated. The data further indicate that a 9% increase [(42.5 mgd - 39 mgd) ÷ 39 mgd] in hydraulic load could be accepted before the limitation is exceeded. If one of the five sedimentation tanks is shut down, however, the maximum flow allowable would be 129,000 m^3/day (42.5 mgd x 4/5, or 34 mgd).[6] Under these conditions, it can be concluded that the Richmond Sunset plant is, at present, operating at a higher rate than the maximum flow rate that will enable them to meet their permit conditions consistently under dry weather conditions.

Analyses of wastewater samples from the plant also showed that during the survey the effluent quality complied with the NPDES permit limitation for pH (range of 6.0 to 9.0). This monitoring showed that residual chlorine concentrations ranged from 4.3 mg/l to 0.4 mg/l on nine consecutive days of sampling (Table 4). The proposed residual chlorine permit limitation, which is not currently in effect, is an instantaneous maximum of 0.0 mg/l.

Bacteriological Characteristics In the effluent (Station E9), median values for total and fecal coliform bacteria were 230 and 9/100 ml respectively (Table 5). The fecal coliform effluent limitation of

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[6] *From 1 December 1973 to 30 July 1974, there were three sedimentation tanks on-stream 85% of the time and four sedimentation tanks on-stream 15% of the time.*

400/100 ml for a 7-day average was not violated. However, despite the high residual chlorine concentrations found in the discharge, *Salmonella enteritidis* ser Agona was isolated from the plume directly adjacent to the discharge (Station 30). It is indicates that although a high residual chlorine was present and was eliminating most of the bacteria, the chlorine contact period was inadequate for proper disinfection of the sewage discharge. The discharge of disease-producing microorganisms creates a nuisance which is prohibited by the California Water Code.

Toxicity Bioassays showed that the chlorinated effluent from the Richmond-Sunset treatment plant was toxic to threespine stickleback. Test fish survived 2 hours or less in undiluted effluent and no fish survived for 24 hours in concentrations higher than 25% effluent (Table 6). At the 25% effluent concentration, fish survival ranged from 40 to 100%; on the average, 85% of the test fish survived a 24-hour exposure. During the next 24-hour interval an additional 12% of the fish died in the tanks containing the 25% effluent. At 72 hours, 60% of the test fish were alive, and at the conclusion of the 96-hour test the average fish survival was 60%. Based on the results of this series of bioassays, the LC50* was calculated to range from 21 to 30.5% with an average LC50 of 27.7%.

These values and results shown elsewhere for North Point and Southeast plant effluents should be considered conservative estimates of the toxicity for the following reasons: (1) the tests were static bioassays which inherently underestimate actual toxicity [illegible], (2) tests were conducted for 96 hours and reflect only acute toxicity, (3) the test organism, threespine stickleback, is reported to be very

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* *LC50 indicates the lethal concentration (actual or interpolated) at which 50% of the experimental animals survived. Some literature sources use TL50 and TL50 which, for the purpose of this report, indicate values equivalent to LC50.*

tolerant to chlorinated sewage effluent;[2] therefore, toxicity is underestimated because more sensitive species reside in the receiving waters adjacent to the sewage plant outfall.

Although effluent limitations on toxicity are not presently in effect, current receiving water limitations prohibit the introduction of "toxic or other deleterious substances" into receiving waters. Thus, the discharge of toxic substances from the Richmond-Sunset plant constitutes a violation of the California Water Quality Control Plan.

Receiving-Water Survey

Water Quality

Physical/Chemical Characterization Receiving waters adjacent to wastewater discharges from the Richmond-Sunset sewage treatment plant were monitored daily, 16-24 September 1975 (Fig. 3). At each location, water depth was measured by a recording fathometer and water clarity was estimated using a Secchi disc. Also, dissolved oxygen, pH, temperature and salinity were measured on the water surface, <0.5 m (<1.6 ft), and approximately 0.5 m (1.6 ft) from the bottom.

Offshore Stations (34, 45, 47) to the south of the Richmond-Sunset discharge were characteristically oceanic with water temperatures of 12.2 to 14.5°C (54.0 to 58.1°F) and salinities of 29.1 to 33.2 ppt. At Stations 31, 33, 37, 39, 41 and 43, directly offshore and northeast of the discharge, water temperatures were generally higher (12.2 to 15.2°C; 54.0 to 59.4°F) and salinities lower (25.4 to 32.4 ppt), reflecting the estuarine influence of San Francisco Bay and possibly the freshwater waste discharge from Richmond-Sunset. The pH levels were similar at all stations (Fig. 4, Table 7).

Dissolved oxygen (DO) measurements showed a trend of decreasing concentration as sampling locations approached the Richmond-Sunset

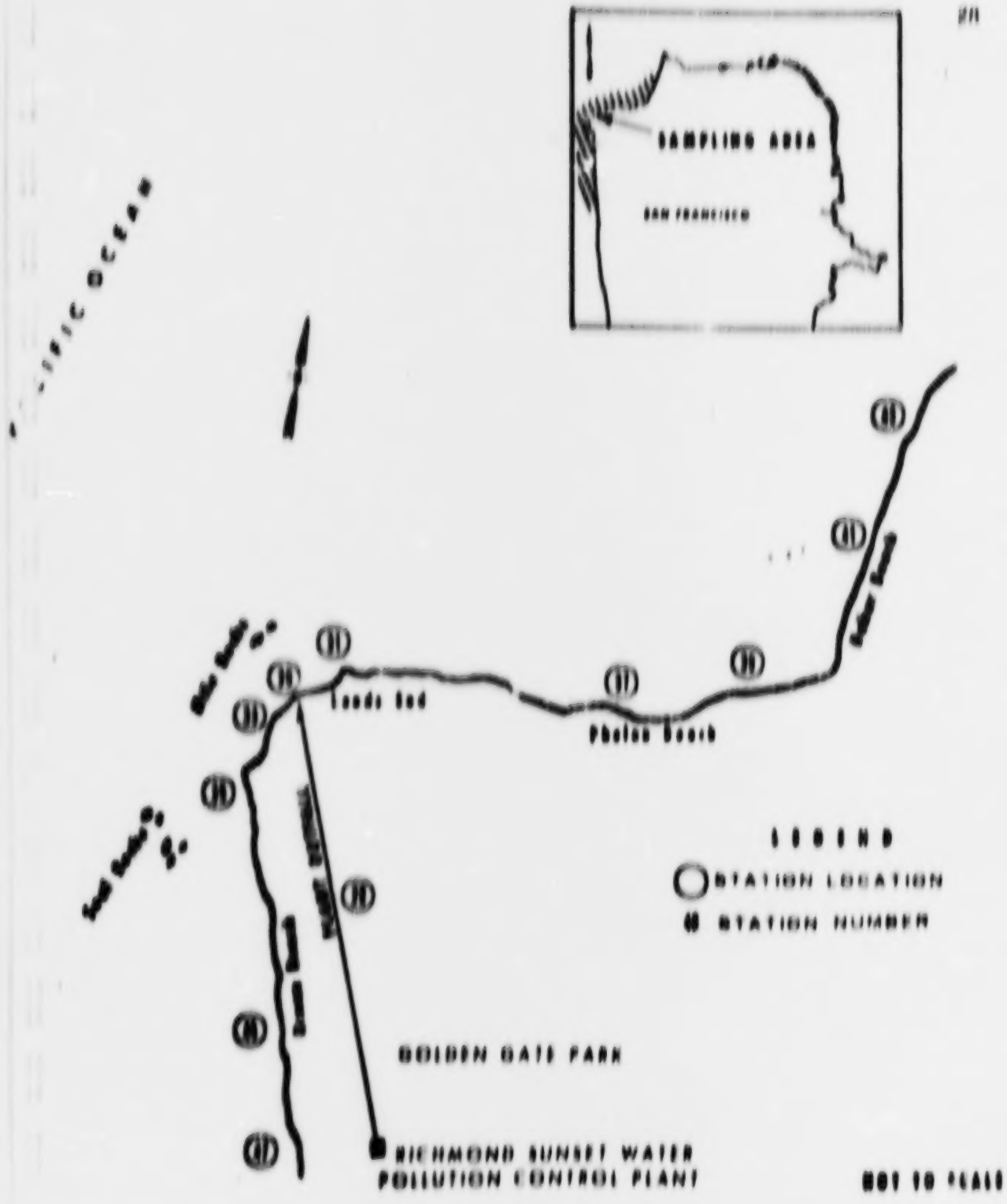

Figure 8. Water Sampling Locations Near Richmond - Sunset Plant San Francisco, California September 1978

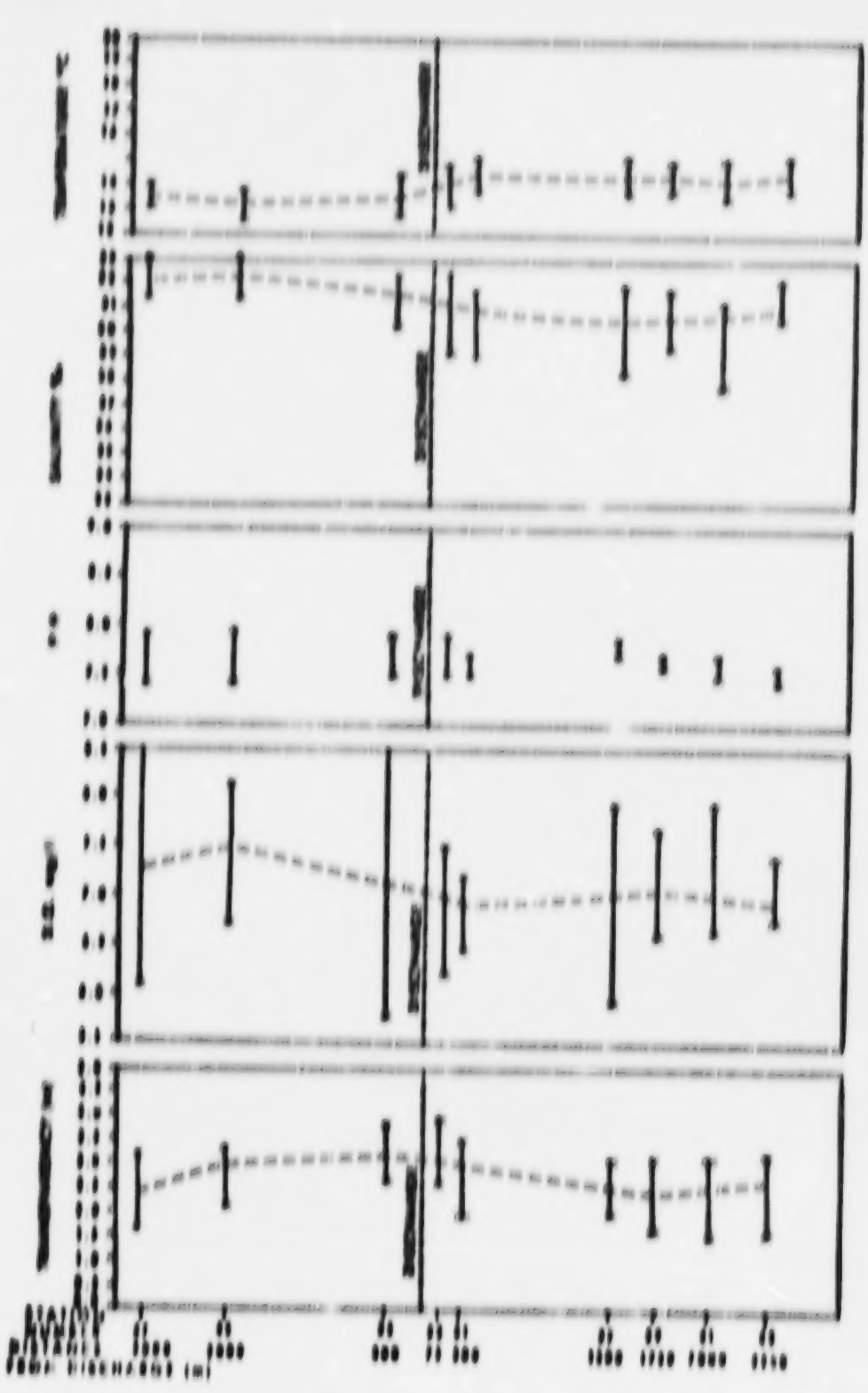

Figure 6. Physical - Chemical Data from Receiving Water Adjacent to the Richmond - Sunset Plant Discharge San Francisco Bay Study, September 1978

discharge at the entrance to San Francisco Bay (Table 7). Offshore, along Ocean Beach (Stations 45, 47), the average DO was about 7.5 mg/l. At Stations 31, 33 and 35, nearest the Richmond-Sunset discharge, the average DO decreased to approximately 7 mg/l and remained near this concentration along the shoreline of Phelan and Baker Beaches (Stations 37, 39, 41 and 43).

No substantial change in water clarity occurred when comparing an offshore station (45) with stations nearest the Richmond-Sunset discharge (31, 33, 35). Lowest water transparency was observed at the inshore beach stations (37, 39, 41, 43, 47) where wave agitation temporarily suspended sand and bottom detritus in the shallower waters.

Receiving waters at Stations 31, 33 and 35, immediately offshore from the Richmond-Sunset plant outfall, were monitored daily from 15-18 September 1975 for dissolved sulfides. Analyses showed the presence of dissolved sulfides in concentrations of 0.01 mg/l (Table 8). The receiving water requirement imposed by the NPDES permit that limits dissolved sulfide to less than 0.1 mg/l was not violated.

Daily monitoring done near the Richmond-Sunset outfall (Stations 31 and 33) from 15-24 September 1975 showed that the sewage effluent contained measureable amounts (>1.0 mg/l) of chlorine after being diluted in the Pacific Ocean. Residual chlorine in concentrations as low as 0.06 mg/l in the receiving water constitutes a hazard to aquatic organisms.[8]

Bacteriological characterization. The California Water Quality Control Plan requires that the median total coliform density for five consecutive samples shall not exceed an MPN of 240/100 ml and the median fecal coliform density shall not exceed 50/100 ml with an instantaneous maximum not to exceed 400/100 ml.

Station 41, offshore from Baker Beach, and Stations 45 and 47, offshore from Ocean Beach, all fall within the influence of the Richmond-Sunset plant discharge (Fig. 5). Station 41 was in violation of the California Water Quality Control Plan (MPN = 540/100 ml, fecal coliforms, instantaneous maximum). Median coliform densities at Stations 45 and 47 also exceeded bacterial limitations of the State Water Quality Control Plan (total coliforms = 280 and 410/100 ml, fecal coliforms = 130 and 87/100 ml, median values, respectively). A list of these bacteriological violations is presented in Table 9. Of additional concern is the fact that *Salmonella enteritidis* ser Ohio was isolated at Station 47. Presence of this disease-producing microorganism further demonstrates contamination by fecal material. Additionally, the discharge of disease-producing microorganisms creates a nuisance which is prohibited by the California Water Code. The high pollution indicator densities at Stations 41, 45 and 47 may be explained as bacterial resuscitation which occurs in the presence of organic materials as the chlorine is diluted.[9] This phenomenon does not occur if the chlorination contact time is adequate.

The remaining receiving water sampling stations in the Richmond-Sunset area did not show NPDES permit violations of bacteriological criteria; however, shellfish harvesting in these waters was impaired by bacterial contamination.

The California Regional Water Quality Control Board has officially recognized but has not designated shellfish harvesting as a beneficial use of ocean shoreline waters near the Richmond-Sunset plant outfall. The State and Federal Standards for shellfish harvesting waters require that the median total coliform density throughout the water column shall not exceed 70/100 ml nor shall 10% of the samples collected exceed 230/100 ml. All stations (Fig. 5) in the area of the Richmond-Sunset discharge except Station 39, off Baker Beach, were in violation of either or both requirements for shellfish waters.

Figure 5. Bacterial Densities - Richmond-Sunset Plant Sampling Area
San Francisco, California September 1974

Oyster Exposure Tests. An oyster exposure study was conducted to further evaluate the quality of receiving water near the outfall of the Richmond-Sunset sewage treatment plant. Four areas were selected for the study (Stations 31, 80, 81 and 82); salinity ranged from 28.9 to 32.1 ppt which is suitable for oyster survival and propagation.[18] The area near Mile Rock (Station 82) served as a reference site. The remaining three tests were located near the effluent field* of the Richmond-Sunset Water Pollution Control Plant (Stations 31, 80, 81).

Cultch containing seed and yearling Pacific oysters (*Crassostrea gigas*) were exposed at each site as described in the Methods section of this report. After 5-1/2 days' exposure at each test area, the oysters were retrieved and examined to determine their condition. The 5-1/2 day duration of the exposure is considered minimal because oysters can remain closed for several days, thereby avoiding exposure to adverse environmental conditions. Larger (juvenile) oysters can remain closed for longer periods than can smaller (seed) oysters. Exposure of oysters in the North Point outfall areas for periods longer than 5-1/2 days could cause mortalities greater than were produced during this study.

Survival of yearling oysters averaged 96% at the four exposure areas. The juvenile oysters from the study areas near the sewage outfall (Stations 31, 80, 81) were shucked and compared with the reference area oysters (Station 82). Close examination and comparison revealed that the tissues from a few oysters (about 2%) exposed at Station 81 were unusually mucous and putrid-smelling while reference oyster tissues had normal texture and no unpleasant odor.

* *Zone of mixed sewage effluent and receiving water, delineated in this study by discolored surface water near the treatment plant outfall.*

Survival of seed oysters ranged from 82 to 100% at the four exposure areas (Fig. 6). The 100% survival of seed oysters occurred at Stations 80 and 82 directly offshore from the Richmond-Sunset discharge. A 96% survival of seed oysters was recorded at shoreline Station 81 while 82% survival was recorded for seed oysters exposed near the shoreline at Station 31.

In summary, oyster exposure tests indicated some impairment to the quality of the oysters that were exposed along the San Francisco shoreline near the Richmond-Sunset sewage treatment plant outfall. No significant toxicity (less than 10% oyster mortality[4]) was recorded at Stations 80, 81 and 82. However, tests showed 18% mortality of seed oysters suspended near the surface of the Pacific Ocean approximately 100 m (330 ft) northeast of the Richmond-Sunset sewage outfall (Station 31). The discharge of substances which are toxic or deleterious to marine life is a violation of the California Water Quality Control Plan.

Benthic Conditions The area of the Richmond-Sunset plant outfall at Land's End was examined by divers. No sludge deposits were observed. Strong currents, wave action, and great amounts of dilution would prevent the deposition of sludge in the area. Benthic communities at Land's End not only reflected the presence of the Richmond-Sunset discharge, but also were influenced by the presence of hard sand and rock substrates and lack of soft substrates such as would exist in sludge beds.

In the intertidal zone within 50 m (164 ft) of the outfall (Station 80), no invertebrate organisms or attached algae were found (Table 10; Fig. 7). Examination of the shoreline to the southwest was not attempted because steep terrain and heavy surf made entry into the area extremely

[4] *10% or less mortality of test organisms is acceptable in a control or reference bioassay.*

Figure 6. Dead Oyster Mortality, Richmond Sunset Discharge Area

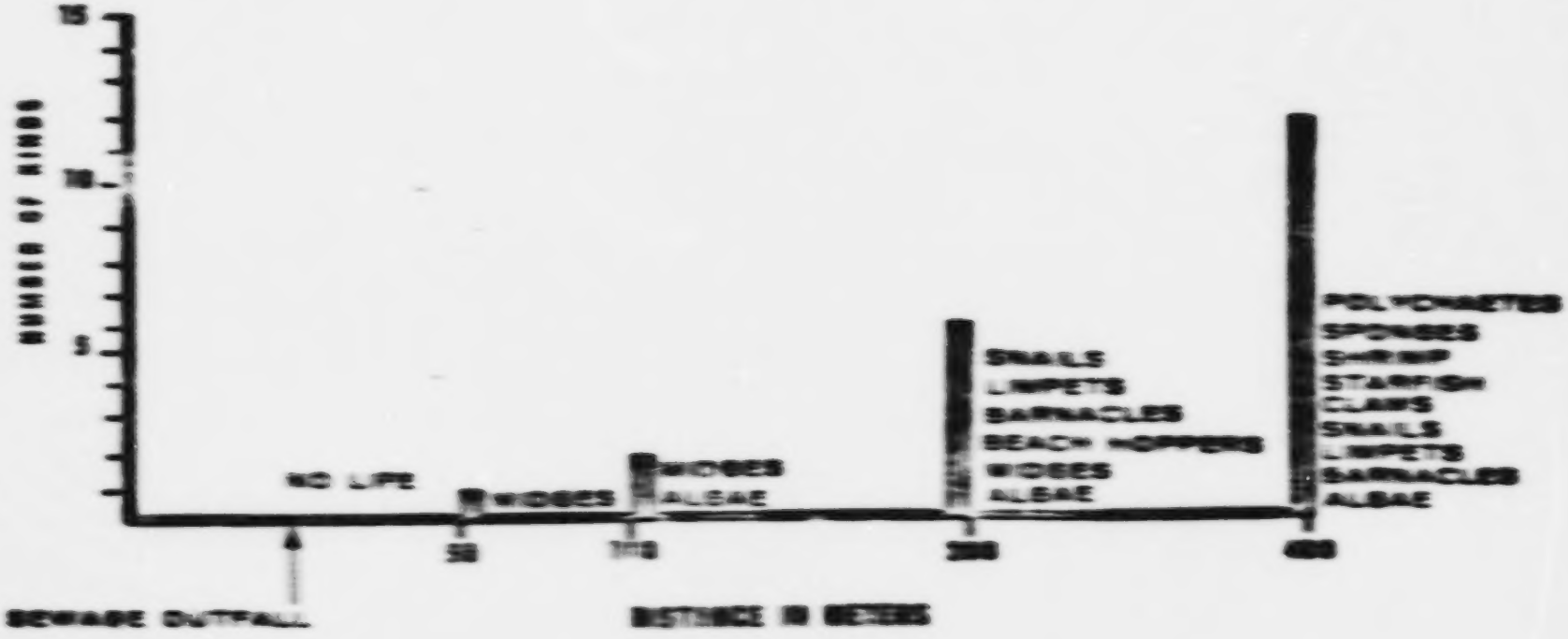

Figure 7. Biological Community of the Intertidal Zone
Northeast of the Richmond-Sunset Plant Outfall
San Francisco, California (September 1973)

hazardous. At 50 to 100 m (164 to 330 ft) from the outfall (Station 70) only a single kind of organism, chironomid midge larvae of the subfamily Orthocladiinae, was found; no attached algae were found in this zone. At approximately 100 m (330 ft) northeast and points farther from the diffuser, intertidal rocks became populated with attached algae (primarily the red alga, *Porphyra*) and the diversity of invertebrates increased. Water quality improved in the area 100 to 200 m (330 to 660 ft) northeast of the outfall (Station 71); the diversity of benthic invertebrates increased to five kinds, including midge larvae, beach hoppers, barnacles, limpets and other gastropods. The diversity of the intertidal invertebrate community from 200 to 400 m (660 to 1,300 ft) northeast of the outfall, at Station 72, increased to eleven kinds, including such typically marine forms as skeleton shrimp, polychaetes, limpets, other gastropods, starfish, clams, barnacles, and sponges. Degradation of the biological community in the vicinity of the Richmond-Sunset outfall is a violation of the California Water Quality Control Plan.

In the littoral zone offshore from the Richmond-Sunset outfall (Station 37), the benthic invertebrate community was quite diverse. Fifteen kinds of organisms were collected from the area, including polychaetes, nematodes, sea slugs, starfish, sponges, scuds, crabs, skeleton shrimp, anemones, chiton, and barnacles. It is judged that the sea bottom in the area of Station 37 was not affected by pollutants discharged from the Richmond-Sunset plant.

NORTH POINT PLANT

In-Plant Survey

Operation and Efficiency

The North Point plant is at 111 Bay Street, east of the Fisherman's Wharf area. The plant was completed in 1951 and has a maximum hydraulic capacity of 605,600 m^3/day (160 mgd). Flows in excess of this are bypassed directly into San Francisco Bay.

The plant serves a dry weather flow area of approximately 3,764 ha (9,300 acres). The contributory area is mostly residential but includes commercial and industrial developments along the Port of San Francisco. It provides conventional primary treatment consisting of pre-chlorination, screening, grit removal, primary sedimentation and post-chlorination. During the survey, ferric chloride and an anionic polymer were being added just downstream from the grit tank from 0700 to 2400 hours each day. During the time that the chemicals were being added, approximately 6,434 l/min (1,700 gpm) of Bay water was being added to the influent to enhance the effect of the chemicals. The final effluent is discharged into San Francisco Bay via four outfalls located at the ends of Piers 31 and 15. A new outfall diffuser system to increase dispersion of the wastes is under construction.

Grit and screening are hauled away for disposal, and the sludge and scum removed from the clarifiers are pumped directly to the Southeast plant for treatment.

Figure 8, a flow diagram of the plant, shows the sampling points. Sampling stations were selected to allow an evaluation of the efficiency of suspended solids removal, the degree of compliance with effluent limitations, and the accuracy of the ferric chloride addition rate.

Suspended solids removals during the survey were 77, 82 and 91% on 17, 18 and 19 September, respectively (Table 11). These results show that the plant was effective in removing suspended solids. The plant is not a conventional one, in that it does not have to treat any return solids from sludge handling -- and this is a significant benefit. An increase in the ferric chloride addition rate could improve suspended solids removal efficiencies. Addition rates up to 150 mg/l as $FeCl_3$ or up to the maximum that can be handled by the sludge removal facilities should be evaluated.

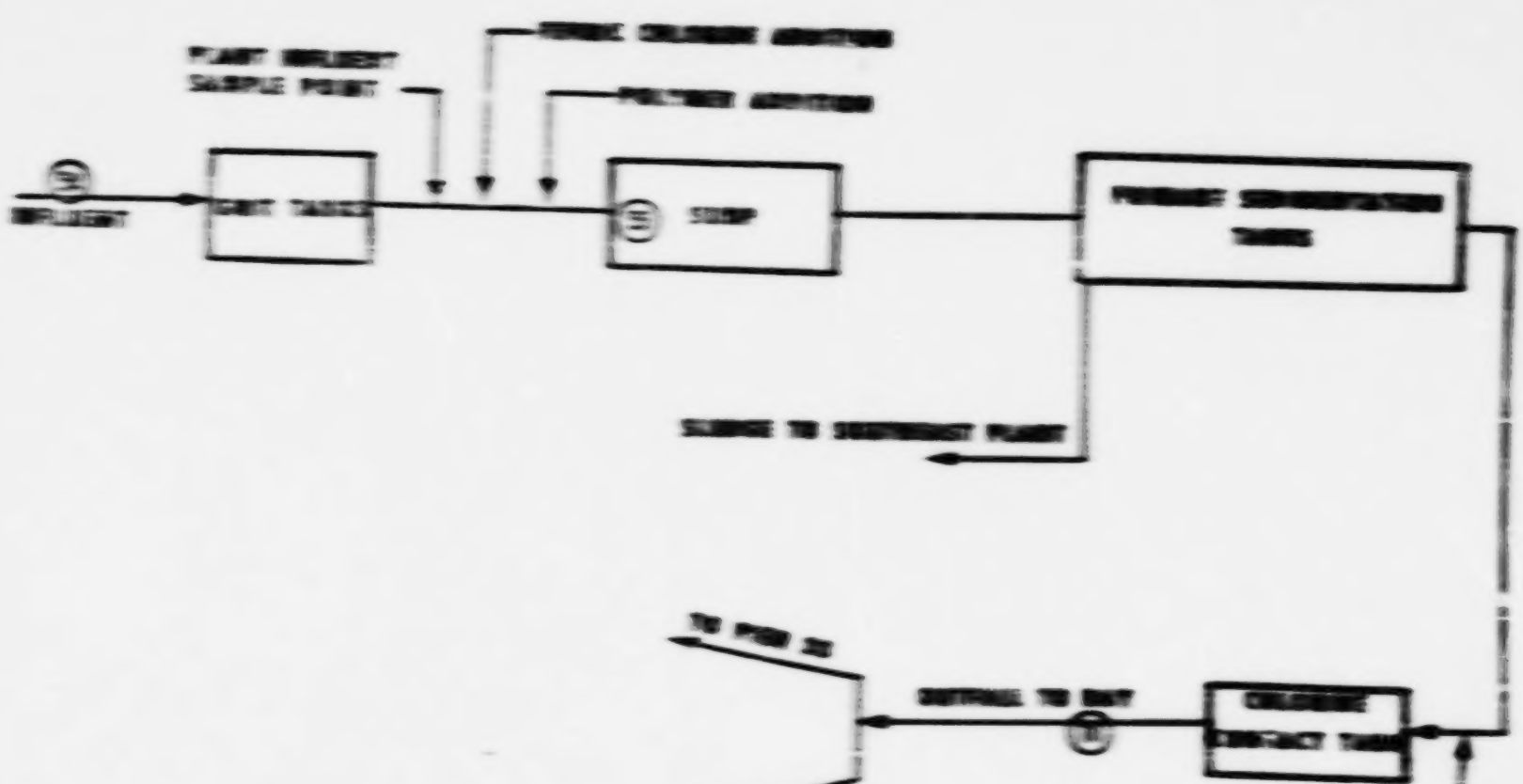

Figure 2. Flow Diagram and Sampling Locations, North Point Plant
City and County of San Francisco

The self-monitoring data from the North Point plant show suspended solids removal efficiencies of 7%, 74 and 73% (avg., 74%) on the 3 days of the survey. As at the Richmond-Sunset plant, the North Point plant staff collected the influent sample downstream from the grit tanks. Survey personnel collected the influent sample upstream of the grit tanks. This difference in sampling locations caused the discrepancy in removal efficiency results. The influent sample should be collected before any treatment occurs.

Table 12 presents the suspended solids removal efficiencies from January to September 1975. These efficiencies varied from 21 to 87% during this period. The low removal efficiencies could have been caused by high wet weather flows.

Flow rates during the survey averaged about 223,300 m^3/day (59 mgd). Assuming a dry weather peak-to-average flow ratio of 1.5, the peak flow would be 335,000 m^3/day (88.5 mgd). This agrees with the reported maximum peak dry weather flow in 1971 of 325,500 m^3/day (86 mgd).

At 335,000 m^3/day (88.5 mgd), with all six clarifiers in use, the surface overflow rate would be 51.3 m^3/m^2/day (1,307 gpd/ft^2). This figure is excessive, even when chemicals are being added. When one of the clarifiers is out of service, the surface overflow rate at peak flow will be 64.0 m^3/m^2/day (1,570 gpd/ft^2), far in excess of optimum conditions.

An operations and maintenance evaluation by the Department of Public Works did not reveal any significant problems at the North Point plant, nor did it recommend any revisions that would appreciably affect effluent quality. Results of the NEIC survey showed that the amount of ferric chloride being added averaged 16.6 mg/l, close to the 15 mg/l target value (Table 13). However, control of the feed rate of ferric chloride was poor. The measured values during the survey ranged from 4.5 to 35.7 mg/l and the standard deviation was 8.08 mg/l. This means

that, 5% of the time, the amount of ferric chloride being added would be less than 0.44 mg/l or more than 32.8 mg/l. Improved control of the ferric chloride addition rate should improve the suspended solids removal efficiency.

Effluent Quality

Physical-Chemical Characterization The limitations now in effect for the North Point plant effluent (NPDES Permit No. CA0037672) state that the arithmetic average of the settleable matter concentrations of six or more samples collected on any one day shall not exceed 0.5 ml/l. The permit further states that the settleable matter concentration of any sample shall not exceed 1.0 ml/l. Both the permit and the California Water Quality Control Plan require that the final effluent shall have a pH of not less than 6.5 nor more than 8.5 units.

Table II shows that the settleable solids concentration was within the prescribed limits at all times but that the pH values of half of the samples ranged from 6.1 to 6.4 and were below the lower limit of 6.5 units. The pH of the influent was not measured, but since no large industry is involved it is probable that the addition of chemicals (ferric chloride and chlorine) was the major cause of the pH violation. Improvement in the control of the ferric chloride addition rate may reduce or eliminate the pH violations.

Water samples collected from the North Point plant discharge contained residual chlorine concentrations in the range of 2.1 to 5.7 mg/l [Table 14]. If these high residual chlorine concentrations are present after 5 October 1975, the North Point plant will be in violation of NPDES permit limitations (0.0 mg/l).

Bacteriological Characterization The North Point plant was in violation of NPDES Permit No. CA0037672 effluent limitations for total and fecal coliform bacteria. The fecal coliform geometric mean during

ten consecutive days of sampling was 770,000/100 ml, far in excess of the permit limitations of 400/100 ml (7 consecutive days, geometric mean). Two violations of the median total coliform bacteria limitation of 240/100 ml occurred in five consecutive samples (Table 15). Nine violations occurred for single samples in excess of 10,000/100 ml. A list of these bacteriological violations is presented in Table 9.

Increased chlorine contact time would decrease the amount of bacterial contamination discharged to the receiving waters; also, residual chlorine concentrations would be reduced. The reduced amount of chlorine that would be required if increased contact time is provided would have the additional benefit of reducing pH violations.

It is the practice of plant personnel to hold bacteriological samples for 10 minutes after collection before they are dechlorinated and subsequently analyzed. This is the expected chlorine-exposure time between the collection site and the point of discharge into the Bay. There is no evidence to support the theory that conditions are similar in both the discharge pipe and the sample bottle; therefore, NPIC samples were collected in accordance with procedures in *Standard Methods*.[1] The dechlorination agent is present in the sample bottle at the time of collection.

Pathogenic *Salmonella enteritidis* ser Anatum and *S. enteritidis* ser Senftenberg were isolated from the discharge. These pathogens (disease-producing microorganisms) discharged into receiving waters create a nuisance in violation of the California Water Code.

Toxicity A series of bioassays demonstrated that North Point chlorinated effluent (2.1-6.7 mg/l) was toxic to threespine stickleback. No test fish survived more than 24 hours in undiluted effluent. In

the series of diluted effluent tests, fish survival ranged from 0 to 70% in the 66% concentrations effluent [Table 16]. The calculated LC50 based on these bioassay findings ranged from 48 to 68%, averaging 59%.

Although effluent limitations on toxicity are not presently in effect, current receiving water limitations prohibit the introduction of "toxic or other deliterious substances" into receiving waters. Thus, the discharge of toxic substances in the North Point wastes constitutes a violation of both NPDES Permit No. CA0037672 and California Water Quality Control Plan receiving water limitations.

Receiving Water Survey

Water Quality

Physicochemical characteristics. Receiving water sampling stations were located along transects adjacent to Piers 33 and 35 [Fig. 9]. Surface temperatures, pH, and salinities clearly demonstrated an influence of the discharges at the end of Piers 33 and 35 [Figs. 10, 11], while corresponding measurements at the bottom demonstrated only a minor influence [Table 15]. Average surface temperatures decreased from 16.1 to 15.5°C (61.1 to 59.9 °F) in an outwardly direction from the discharge along the transects, while surface salinities and pH increased.

The increase in pH values on 15, 17 and 18 September exceeded the limits of 0.2 pH unit variation both in the receiving water limitations of Permit No. CA0037672 issued to the North Point plant and in the California Water Quality Control Plan for enclosed Bays and Estuaries [Table 17]. On 15 September, a pH value of 7.8 was obtained on the surface water adjacent to Pier 35, directly over the discharge, while at the control station outside the influence of the discharge the pH was 8.5. On 17 September, a pH value of 7.0 was recorded adjacent to Pier 35

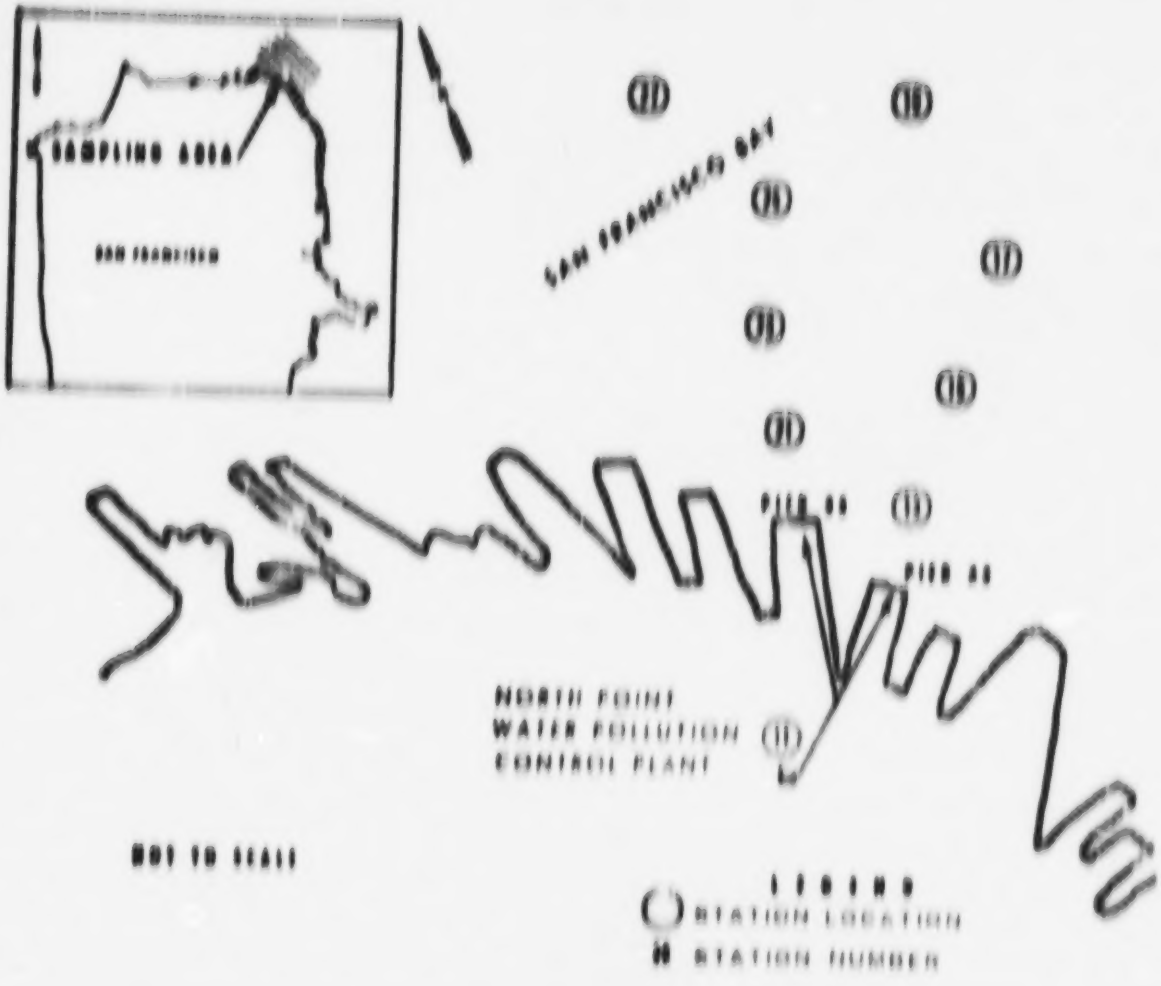

Figure 9. Water Sampling Locations Near North Point
Water Pollution Control Plant
San Francisco, California September 1975

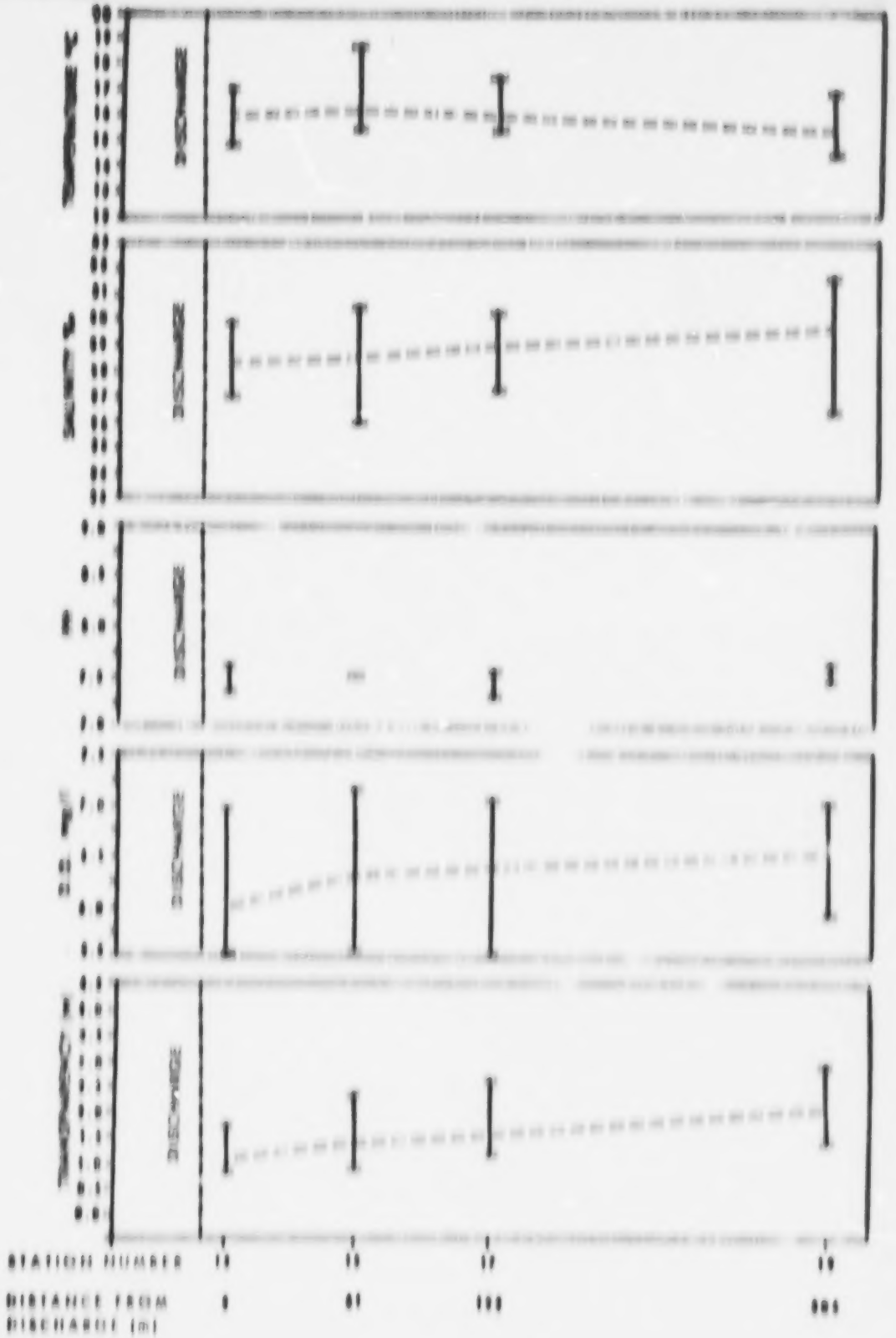

Figure 10 Physical - Chemical Data from Receiving Water Adjacent to the North Point Plant Pier 33 San Francisco Bay Study, September 1975

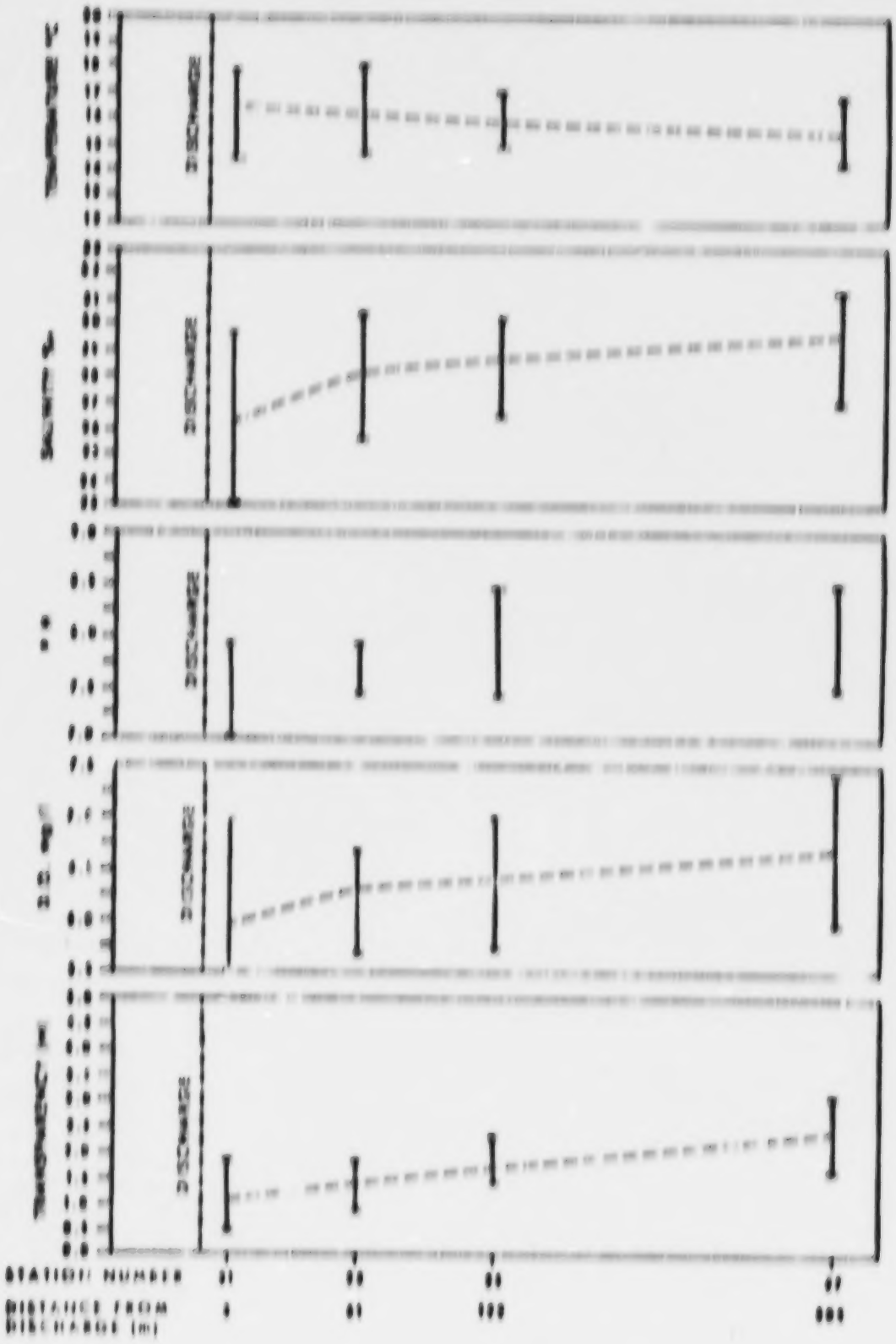

Figure 11 Physical - Chemical Data from Receiving Water Adjacent to the North Point Plant Discharge
San Francisco Bay Study, September 1978

while at the control station a value of 7.5 was recorded. On 10 September the pH adjacent to Pier 31 over the second discharge was 7.1 while at the control station the pH was 7.6, indicating an additional violation.

Average surface DO increased markedly with distance from the ends of Piers 31 and 35. Values of 6.0 and 5.9 mg/l were obtained at Stations 13 and 21 adjacent to Piers 31 and 35, respectively. At the next stations away from the piers (15 and 23) DO had increased to 6.3 mg/l, and at the control stations (19 and 27) outside the influence of the discharges DO had risen to 6.6 mg/l. The minimum surface DO recorded during the survey was 5.0 mg/l at Station 21 adjacent to Pier 35 on 15 September. Bottom DO reflected a similar but less pronounced trend of increasing DO along both Pier 31 and 35 transects in an offshore direction. Bayward from the end of Piers 31 and 35, an almost linear trend of increasing transparencies was observed. Values increased from 1.0 m (3.3 ft) near the discharges to 2.5 m (8.2 ft) at control Stations 19 and 27.

Chlorine was detected in the receiving waters in the vicinity of the North Point discharges (Table 14). Residual chlorine (~1.6 mg/l) was measured at Stations 21, 13, 15, 23 and 25. Chlorine in the receiving waters in concentrations as low as 0.06 mg/l has been found to be toxic to aquatic organisms.[7]

Although the NPDES permit limitation of 0.1 mg/l dissolved sulfide was never equaled or exceeded, sulfide concentrations approaching the limitation were measured at several locations near North Point (Table 16). On 16 September 1975, at Stations 17, 19, 21 and 23, 0.08 mg/l dissolved sulfide was detected, while at Stations 13 and 15 the dissolved sulfide concentrations were 0.04 mg/l.

Bacteriological Investigations Three stations (13, 15 and 25) in receiving waters of the North Point plant discharges (Fig. 12) exceeded the fecal coliform limitation of 400/100 ml set by the California Water Quality Control Plan. A single sample maximum violation of 1,600/100 ml fecal coliforms occurred at Station 13 (Table 15). Two samples exceeded this limitation at Station 15 with fecal coliform densities of 920 and 2300/100 ml, respectively. Station 25, near Pier 35, exceeded the Water Quality Control Plan limitation with a maximum MPN value of 2,400 fecal coliforms/100 ml. A list of these bacteriological violations is presented in Table 9.

The California Regional Water Quality Control Board has officially recognized shellfish harvesting as a beneficial use of waters of San Francisco Bay; however, the North Point outfall area has not been designated as a shellfish harvesting area. The U. S. Public Health Service Shellfish Harvesting Standards require that the median total coliform density throughout the water column shall not exceed 70/100 ml nor shall 10% of the samples collected exceed 230/100 ml. Stations 13, 15, 17, 21 and 23, adjacent to the North Point discharge, exceeded these standards.

Oyster Investigations Cultch containing seed and juvenile Pacific oysters (*Crassostrea gigas*) were exposed at the ends of Piers 33 and 35 (Stations 13 and 21). After 5 1/2 days' exposure, the oysters were recovered from Piers 33 and 35 (the oyster set was lost from an offshore reference location) and examined to determine their condition.

Mortality of seed oysters was 22% at Pier 33 and 11% at Pier 35, as compared to no mortality at the Mile Rock reference area (Fig. 13). Juvenile oyster survival was better than that of seed oysters; 14% mortality occurred at Pier 33 and no mortality occurred at Pier 35. However, examination revealed that some of the surviving oyster tissues from the Pier 33 exposure were unusually mucous and putrid-smelling. Oyster tissues from the reference area had normal texture and no unpleasant odors. Overall, mortality of seed oysters was 28% and mortality

Figure 12. Bacterial Sampling - North Point Plant Sampling Area
San Francisco, California September 1975

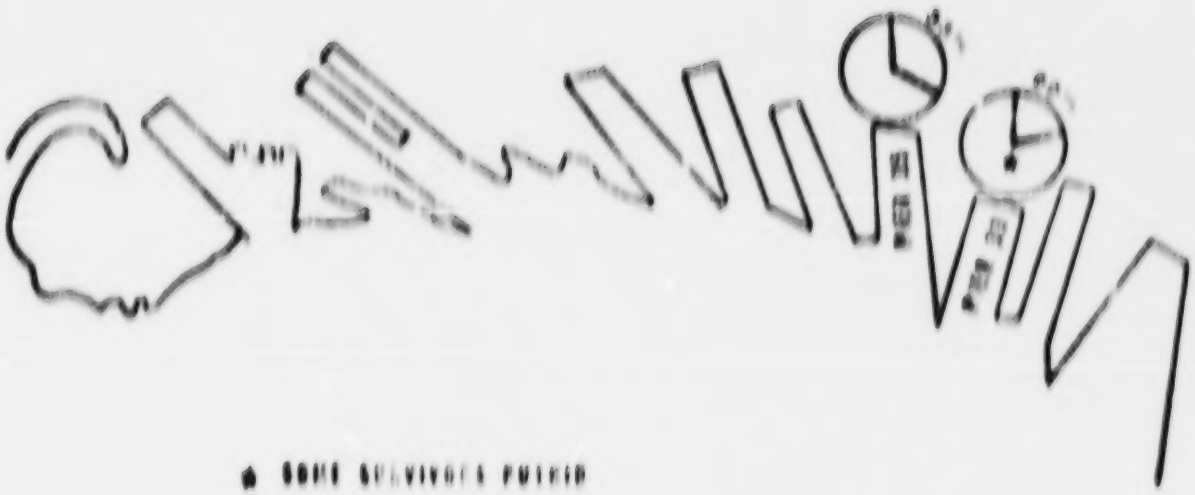

Figure 11. Seed Oyster Mortality, North Point Discharge Area

of juvenile oysters was 12% in the North Point outfall area. The discharge of substances which are toxic or deleterious to marine life is a violation of NPDES Permit No. CA0037672 and the California Water Quality Control Plan.

Benthic Conditions. Benthic communities were influenced both qualitatively and quantitatively by North Point plant discharges. In the areas of Piers 33, 31 and 29 (Stations 14, 66 and 67) water quality was poor and the Bay bottom was inhabited primarily by worms and pollution-tolerant polychaete worms (Table 19). From near Pier 33 (Station 14) southeasterly, approximately 200 m (600 ft) to the vicinity of Pier 31 (Station 66), a large sludge deposit was observed. The benthic community inhabiting the sludge bed consisted primarily of worms, polychaete worms, nematodes, and a few clams; the benthic population numbered nearly 21,000/m^2. At no other location near North Point was sludge detected, and at no other point was the density of the benthic community so great. Southeast of Pier 29 (Station 67) the bottom consisted of sand and clay inhabited by low numbers of worms and polychaete worms.

The California Water Quality Control Plan and NPDES Permit No. CA0037672 specifically prohibit sludge deposits and the discharge of toxic or deleterious substances causing degradation of benthic communities. The sludge deposit and the degraded benthos at North Point each constituted separate violations of the California regulations.

From Pier 35 west to Pier 39, the bottom of the Bay is subjected to nearly continuous scouring by strong tidal currents and dredging is practiced; no sludge deposits were observed. The benthos in this reach consisted predominantly of low densities of polychaete worms and pollution-tolerant nematodes, with lesser numbers of tunicates, clams, cockles and isopods.

At the sampling points farthest from the North Point discharges, benthic communities contained some polychaete worms, but were dominated by organisms considered to be more sensitive to organic pollution. Offshore 500 to 600 m (1,600 to 2,000 ft) at Stations 18 and 28, pollution-sensitive barnacles were the predominant benthic invertebrates.

SOUTHEAST PLANT

In Plant Survey

Operation and Efficiency

The Southeast Water Pollution Control plant is at 1700 Jerrold Ave. this facility, completed in 1951, may be considered as two plants constructed side-by-side. The first section of the plant provides conventional primary treatment to wastes from the heavily industrialized southeast area of the City of San Francisco. The second section consists of the sludge digestion and processing facilities which handle not only the sludge from the Southeast plant but also the sludge transferred from the North Point plant. The Southeast plant, which serves an area of approximately 4,130 ha (10,200 acres), was designed for an average dry weather flow of 113,600 m^3/day (30 mgd) and a peak wet weather flow of 265,000 m^3/day (70 mgd). The normal dry weather flow at present is about 68,100 m^3/day (18 mgd).

Principal treatment units include pre-chlorination, screening, grit removal, primary sedimentation and post-chlorination. At the average dry weather flow of 68,000 m^3/day (18 mgd), the sedimentation tanks provide a residence time of 4.6 hours and a surface overflow rate of 18.9 m^3/m^2/day (465 gpd/ft^2). Raw sludge from the sedimentation tanks is pumped to the adjacent sludge digesting and processing plant. During the survey conducted on 17, 18 and 19 September, one of the four sedimentation tanks was out of service.

Raw sludges from both the Southeast plant and the North Point plant are pumped to the sludge processing section of the Southeast plant. The North Point sludge is thickened, mixed with the Southeast sludge and pumped to the digesters. The digested sludge is elutriated and filtered. The elutriate and filtrate are returned to the head end of the grit removal tanks. The filter cake and the grit and screenings from primary treatment are hauled to sanitary landfill.

Ferric chloride is added in the influent channel prior to grit removal and the polymer is added at the Parshall flumes, downstream from grit removal. During the survey, the target ferric chloride dosage was 30 mg/l (as $FeCl_3$). Figure 14 is a flow diagram of the Southeast plant; selected sampling points are indicated.

After chlorination, plant effluent flows to the outfall booster pumping station on the south side of Islais Creek. The effluent may flow by gravity from the pumping station or be pumped to a submerged outfall which extends about 244 m (800 ft) offshore from the Army Street terminal. A 91 m (300 ft) diffuser section is located about 12 m (40 ft) below mean lower low water.

The suspended solids removal efficiencies for this plant were calculated on the basis of solids in the influent and in the effluent. This method of calculation does not take into account the solids that enter the plant from the North Point facility. The ratio of solids from the North Point plant to solids in the Southeast influent ranged from 0.6 to 2.7.

The daily suspended solids removal efficiencies on 17, 18 and 19 September were found to be 62, 84 and 93%, respectively, for an average removal of 80% (Table 21). Little information is available on the efficiencies that could be expected at a plant of this type. The

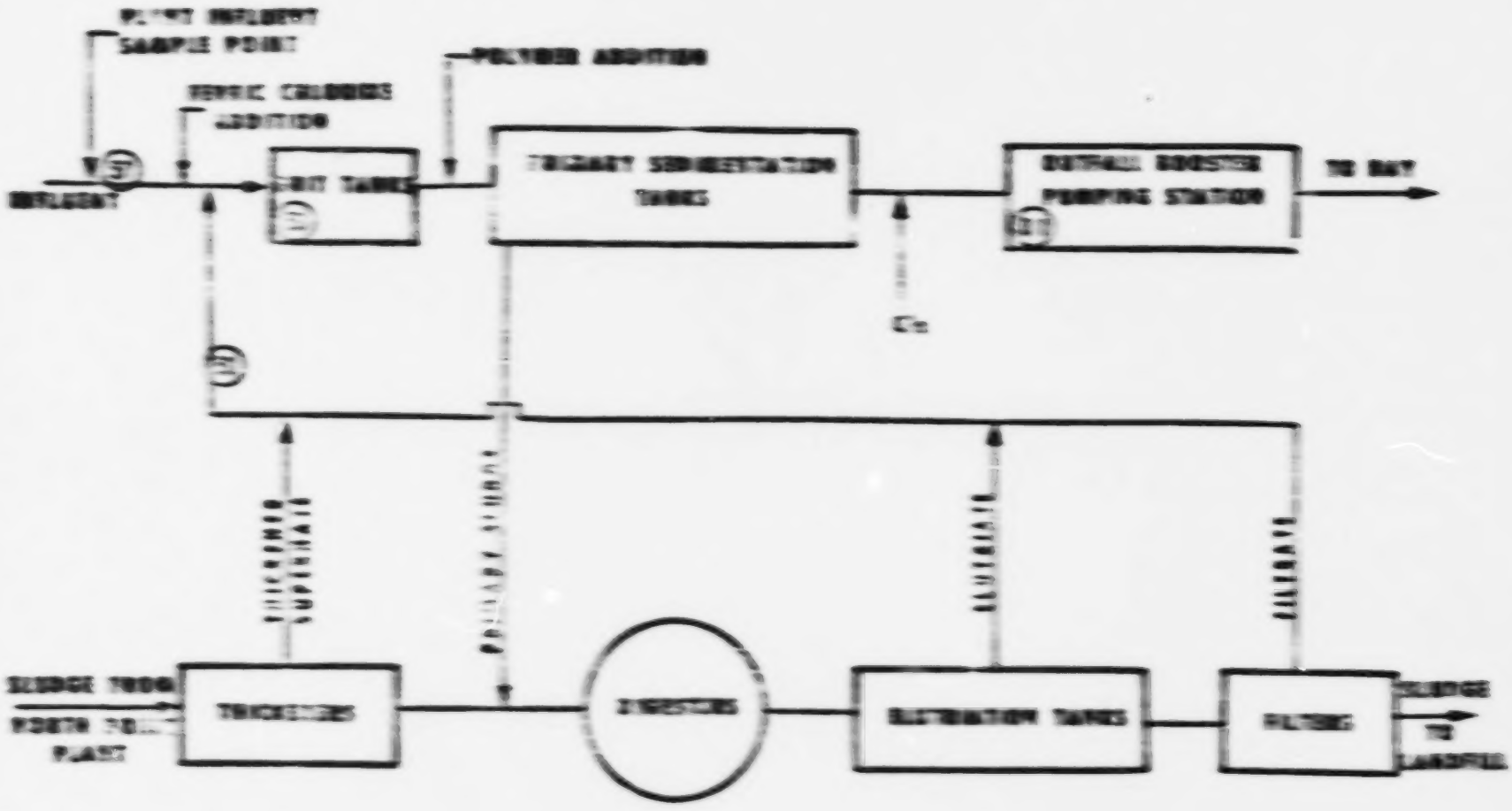

Figure 14. Flow Diagram and Sampling Locations, Southeast Plant

City and County of San Francisco

removal efficiencies reported by the plant staff for this same time period were 69, 76 and 62%, respectively (avg., 69%). The largest discrepancy (31%) occurred on 19 September when the survey influent sample contained 910 mg/l of suspended solids. This is approximately three times the expected value and could have been the result of a contaminated sample.

The high suspended solids removal efficiencies found at the Southeast plant were unexpected. The plant management stated that the variable nature of industrial input caused problems in that the sulfide in the industrial wastes nullified the effect of the ferric chloride. Another problem reported was that the polymer delivery lines between the polymer pumps and the Parshall flumes (where polymer enters the main stream) were so large that polymer control is difficult.

Table 20 shows that the ferric chloride dosage averaged 33.3 mg/l and that the variation in dosage was slight during the 3-day in-plant survey. However, management has indicated that the control of chemicals at this plant is poor. It has been reported that ferric chloride usage can vary almost two-fold from one day to the next when there is no appreciable change in flow. Improvement in the accuracy of control of chemical addition would increase the suspended solids removal efficiency.

An increase in the ferric chloride addition rate could improve suspended solids removal efficiencies. Addition rates up to 150 mg/l or up to the maximum that could be handled by the sludge removal system should be evaluated.

The performance of any plant will be improved if variations in influent characteristics can be minimized. The unusually highly variable influent is a problem at the Southeast plant. If the contributing industries equalize their input to the sewer, the fluctuations in

effluent quality would be reduced. It would be even more beneficial if the industries pre-treat to remove noncompatible wastes.

During an earlier survey[12] of the Southeast plant by the EPA, severe short-circuiting in the primary clarifiers was noted. The clarifiers seem to be operating efficiently so a large expenditure of manpower and funds to solve this problem does not seem warranted.

The report on the earlier survey recommended that the return flow from sludge handling be added to the mainstream well before the addition of ferric chloride. This flow, during the survey, averaged 7,950 m^3/day (2.1 mgd). A 10-inch line could conveniently handle up to 18,000 m^3/day (5 mgd) and should not be expensive to install.

Another recommendation of the March report was that the flocculation study using the paddles be repeated when adequate control and mixing of chemicals is obtained. Air agitation, downstream from the ferric chloride addition point, has been installed since the April survey and mixing now appears adequate. The previous flocculation studies showed that the input of mechanical energy caused little or no change in effluent quality. Repeating this study with varying ferric chloride doses may result in operating practices that will improve plant performance.

The suspended solids in the return from the sludge handling system were 26, 21 and 8% of the total solids entering the grit chambers on the three days of the survey. These are considerably higher than the similar figures for the Richmond-Sunset plant (9, 8, and 14%).

Table 22 presents the suspended solids removal efficiencies at the Southeast plant from January to September 1975 as reported in the self-monitoring data. Removal efficiencies varied from 0 to 84.1%. The low

values may have been caused by high wet weather flow or by industrial surges affecting the coagulation properties of the ferric chloride.

Effluent quality

Physical/chemical characteristics. Settleable solids removal by the Southeast plant was found to be in compliance with NPDES Permit No. CA0037664 which limits settleable matter to a maximum of 1.0 ml/l and a daily average of 0.5 ml/l.

None of the effluent samples taken during the survey were in violation of permit limitations for pH (6.0 - 9.0).

The chlorine residual in the Southeast plant discharge ranged from 3.3 to 7.2 mg/l [Table 23]. The proposed residual chlorine limitation, which is not currently in effect, is an instantaneous maximum of 0.0 mg/l.

Bacteriological characteristics. The Southeast Water Pollution Control Plant was in violation of NPDES Permit No. CA0037664 effluent limitations for total coliform bacteria. Total coliform bacteria densities were continually in excess of the median limit of 240/100 ml [Table 24]. Four violations occurred for the single sample maximum of 10,000 total coliforms/100 ml when verified by a sample taken within 48 hours. A list of these bacteriological violations is presented in Table 9. Increased chlorine contact time would decrease the amount of bacterial contamination discharged to the receiving waters; also, residual chlorine concentrations would be reduced.

Plant sampling practices involve a 10-minute holding time prior to dechlorination of bacteriological samples, this is an attempt to simulate the expected chlorine contact period between the collection site and the point of discharge into the Bay. There is no evidence to support the theory that conditions in both the discharge pipe and the sample bottle

are similar; therefore, MPN samples were collected in accordance with procedures described in *Standard Methods*. The dechlorinating agent is present in the sterile bottle prior to collection of the sample.

Pathogenic bacteria, *Salmonella enteritidis* ser Derby were isolated from the effluent at Station 1, located at the outfall booster pump. The discharge of these microorganisms creates a nuisance and is prohibited by the California Water Code.

Toxicity The chlorinated effluent from the Southeast plant was toxic to threespine stickleback. Bioassays showed the effluent dramatically changed from day to day (Table 25; Series 1 versus Series 2 and 3). Effluent used for the first set of replicate bioassays was found to be the least toxic to threespine stickleback. Fish survival decreased only in the undiluted effluent. Mortalities were recorded after 48 hours of exposure and no test fish survived the 96-hour bioassay in the tanks containing undiluted effluent. In two successive bioassays (Series 2 and 3) no test fish survived in effluent concentrations higher than 10%. In fact, most of the test fish died within 4 hours. Based on these bioassay results, the LC50 was calculated to range from 1/<70%, with an average of 3%. The discharge of "toxic or deleterious substances" is a violation of NPDES Permit No. CA0037664 and the California Water Quality Control Plan.

Receiving Water Survey

Water Quality

Physical and Chemical Characteristics Physical and chemical characteristics of the receiving waters adjacent to the Southeast sewage treatment plant were monitored daily from 15-24 September 1975 (Fig. 15). At each location water depth was measured by a recording fathometer and

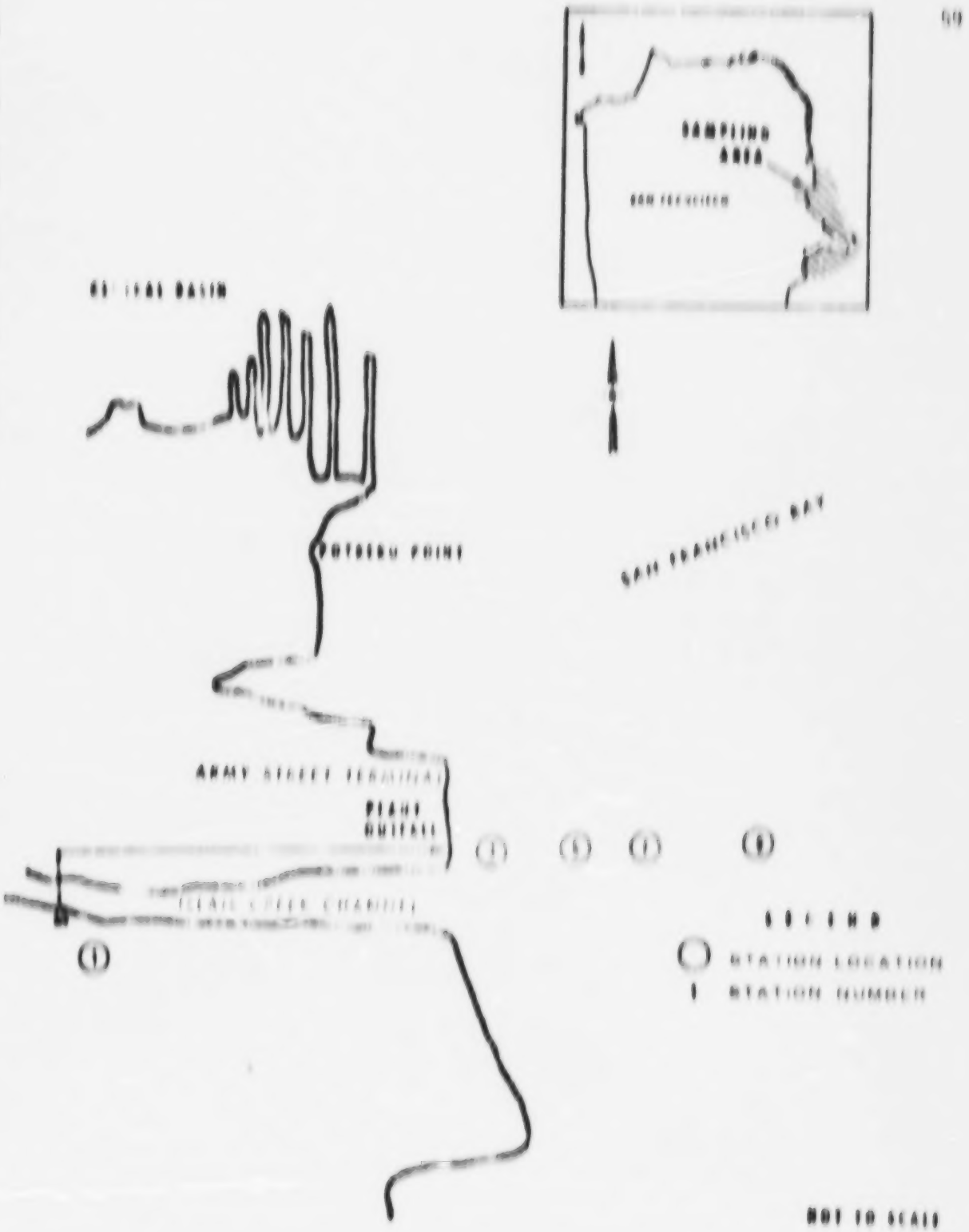

Figure 15. Water Sampling Locations Near Southeast Water Pollution Control Plant San Francisco, California September 1975

water clarity was estimated using a Secchi disc. Dissolved oxygen, pH, temperature and salinity were measured on the water surface, 0.5 m (~1.6 ft), and approximately 0.5 m (1.6 ft) from the bottom. Tidal current effects were not considered significant because some sampling locations were shifted to remain within the discharge plume. The influence of the Southeast plant effluent was not as apparent in the Bay as was that of the North Point plant effluent. A trend in the physical-chemical observations that would delineate the presence of the Southeast plant effluent was evident only in the transparency measurements.

Temperature remained relatively constant at all stations with values fluctuating around 17°C (63°F) on the surface and near bottom (Fig. 16 and Table 26). Salinity and pH measurements were also similar at all stations along the transect.

Dissolved oxygen at the surface and bottom showed no apparent increase in a direction from the stations nearest the diffusers to the control station outside the visible plume. Mean DO values ranged from 6.2 to 6.5 mg/l. The lowest recorded DO was 5.2 mg/l which occurred at the two stations furthest from the discharge (07 and 09).

Average transparencies decreased at stations influenced by the plume, from 1.4 to 1.5 m (4.6 to 4.9 ft), while at the control station the average transparency was 1.9 m (6.2 ft). This reflects the general lack of clarity of waters in this section of the Bay.

Receiving waters at Stations 3, 5 and 7, offshore from the Fore Street terminal and adjacent to the Southeast plant discharge, were monitored daily for dissolved sulfides from 15-18 September 1975. Analyses showed the presence of dissolved sulfides in concentrations of 0.01-0.07 mg/l (Table 27). The NPDES requirement for receiving waters limits dissolved sulfides to <0.1 mg/l; there was no violation of the sulfide limitation.

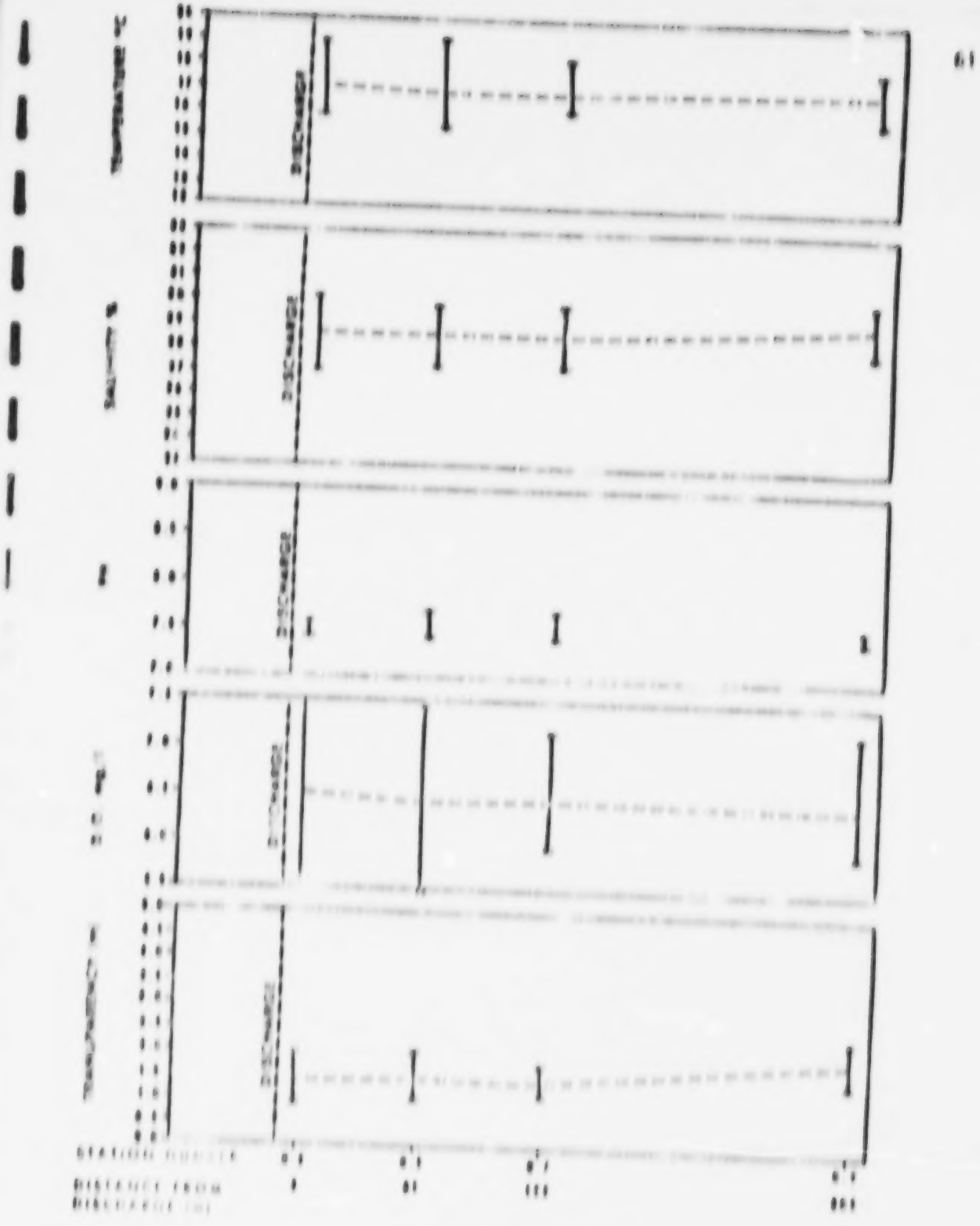

Figure 10 (Section): Chemical Data from Receiving Water
Adjacent to the Southeast Plant Discharge
San Francisco Bay Study: September 1975

Daily monitoring of receiving waters at Stations 4 and 5, near the Southeast plant discharge, showed measurable amounts of chlorine (1.0 mg/l). Residual chlorine in the receiving waters as low as 0.06 mg/l has been reported to be toxic to aquatic organisms.[8]

Bacteriological monitoring. Fecal coliform bacterial densities at Station 5 exceeded the State of California Water Quality Control Plan (no sample shall exceed a maximum fecal coliform density of 400/100 ml). At Station 5, which is within the influence of the Southeast plant discharge, fecal coliform densities ranged from 2 to 920/100 ml with one sample exceeding the 400 fecal coliforms/100 ml requirement [Tables 9 and 24, Fig. 17]. The remaining receiving water stations in the Southeast plant discharge area were in compliance with the receiving water quality objectives.

The California Regional Water Quality Control Board has officially recognized shellfish harvesting as a beneficial use of San Francisco Bay; however, the Southeast plant outfall area has not been designated as a shellfish harvesting area by the Water Quality Board. Receiving waters within the influence of the Southeast plant discharge, Stations 3 and 5, were in excess of both of the U. S. Public Health Service Bacteriological Standards for Shellfish Waters (not more than 10% of samples shall exceed 230 total coliforms/100 ml, or the median total coliform density shall not exceed 70/100 ml).

Oyster bioassays. An oyster exposure study was conducted to further evaluate the quality of receiving water near the outfall of the Southeast sewage treatment plant. The four areas that were selected for the study (Stations 78, 79, 85 and 90) had salinities that ranged from 21.7 to 30.1 ppt. These levels are suitable for oyster survival and propagation.[9] The area near Mile Rock (Station 82) served as a reference site. The four tests were located within the effluent field of the Southeast plant.

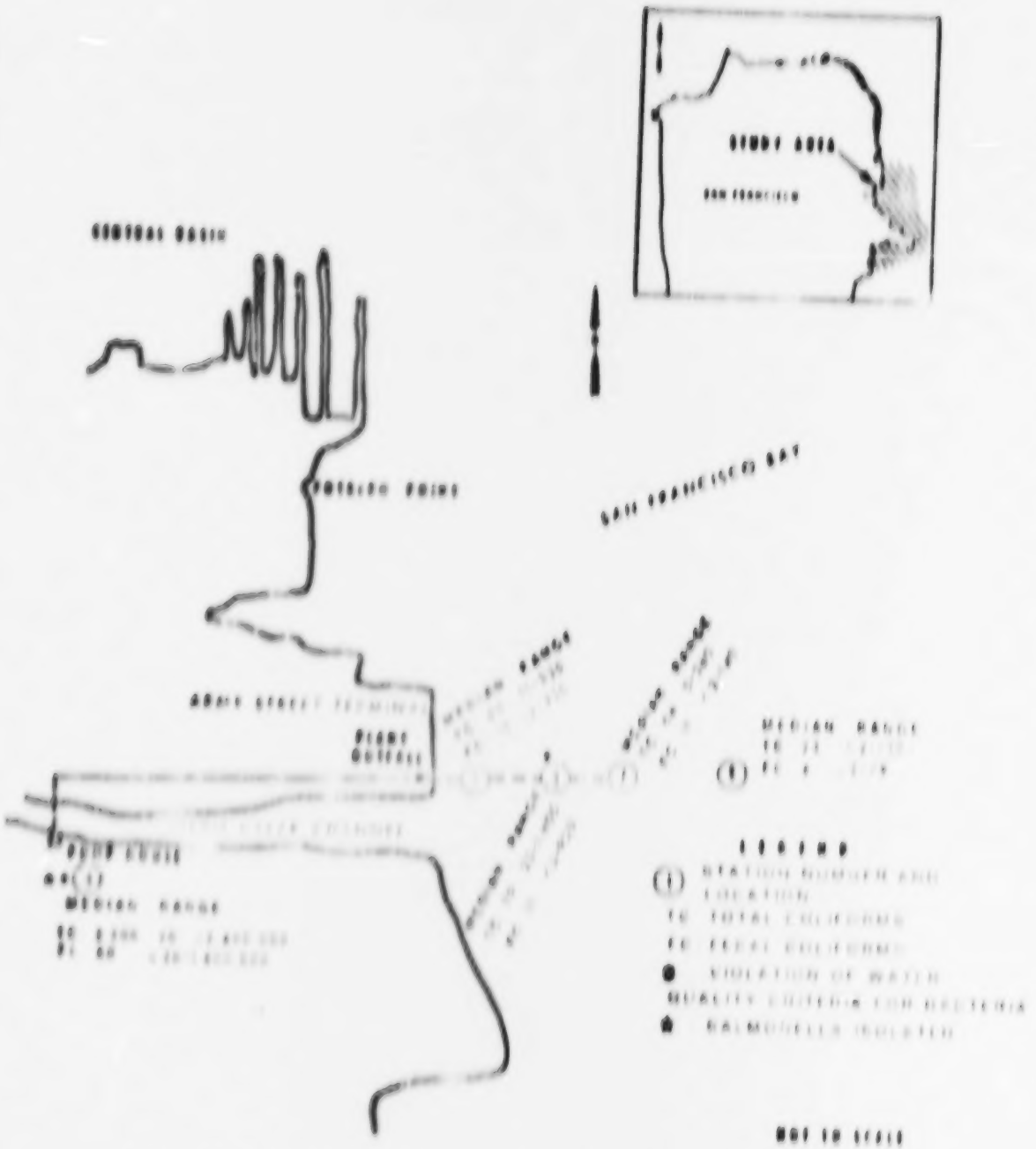

Figure 19 Bacterial Densities - Southeast Plant Sampling Area
San Francisco, California September 1978

Seed and yearling Pacific oysters (*Crassostrea gigas*) were exposed at each site as described in Appendix B, Methods. After 5-1/2 days' exposure at each test area, the oysters were retrieved and examined to determine their condition.

Mortality of yearling oysters averaged 5% at the four exposure areas. The surviving juvenile oysters from the study areas near the sewage outfalls (Stations 78, 79, 85 and 90) were shucked and compared with the reference area oysters (Station 82). Examination revealed that the tissues from some oysters exposed at Station 90 were unusually mucous and putrid-smelling, while reference oyster tissues appeared normal in texture and odor. The discharge of substances which are toxic or deleterious to marine life is a violation of the NPDES Permit No. CA0037664 and the California Water Quality Control Plan.

Mortality of seed oysters ranged from 7 to 58% at the four exposure areas. As shown in Figure 18 the greatest oyster mortality occurred at the stations located nearest the sewage outfall.

Benthic populations were influenced by the Southeast plant discharge. The NPDES Permit No. CA0037664 and the California Water Quality Control Plan specifically prohibit the deposition of bottom deposits and the discharge of toxic or deleterious substances causing degradation of benthic communities. A sludge deposit 60 m (200 ft) wide extended along the Southeast plant (Station 86, 87 and 88); this actively-decomposing sludge was dark brown and had a strong sewage odor. Sediment samples from locations farther from the diffuser may have contained older, stable sludge, but they consisted mostly of odorless clay and silt. At the sampling locations nearest the Potrero Power Plant (Station 84), sediments consisted of clay plus a layer of black (anaerobic) matter. The black layer may have been old, stable sludge

Figure 18 Seed Oyster Mortality Southeast Plant Discharge Area

(which is usually black), but was not the dark brown color of actively decomposing sludge and was not odoriferous.

Benthic invertebrate communities inhabiting all of the areas in the vicinity of the Southeast plant discharge were characteristic of soft, organically rich substrates. Scuds and polychaete worms were extremely numerous (2,079 to 46,960/m^2; 190 to 4,370/ft^2) and clams, tunicates and cockles were abundant (Table 28).

At Station 65 located 1,000 m (3,040 ft) south of the diffuser, the bottom of the bay consisted of hard sand, silt and shell. Here, the benthos consisted of polychaete worms, clams, and amphipods in low numbers.

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APPENDIX A
SURVEY RESULTS

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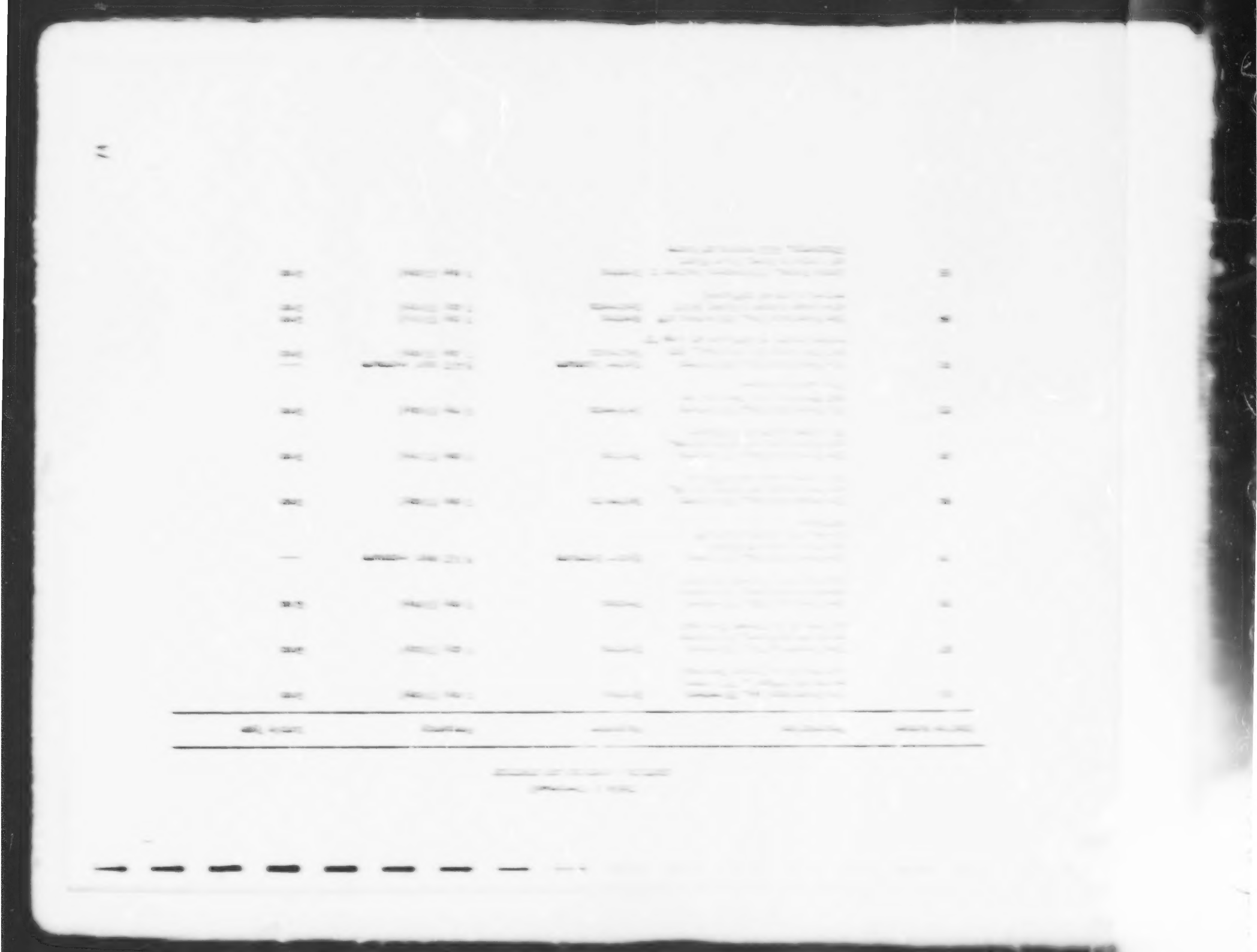

Table 3

SELF-MONITORING DATA - RICHMOND FOREST PLANT

Date 1975	Settleable Solids (ml/l) Avg. of 6/Day			pH			Suspended Solids Removal (%)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	0.19	0.61	1.81	-	-	-	8	54	84
Feb.	0.21	0.44	0.62	7.1	7.9	8.1	0	51	69
Mar.	0.22	0.41	0.58	6.6	7.0	7.0	51	64	86
Apr.	0.19	0.30	4.8	7.0	7.2	7.5	30	68	92
May	0.13	0.22	0.35	7.0	7.1	7.3	48	69	86
June	0.15	0.23	0.33	7.0	7.1	7.2	53	61	89
July	0.08	0.16	0.37	6.6	7.0	7.2	29	61	76
Aug.	0.03	0.13	0.21	7.0	7.2	7.3	42	57	80
Sept.	-	-	-	-	-	-	48	63	80

Table 4

RESIDUAL CHLORINE INVESTIGATION
RICHMOND-SUNSET PLANT EFFLUENT AND RECEIVING WATERS
September 1976

Station Number	Station Description	Date	Residual Cl_2 (mg/l)
01	Richmond-Sunset Plant Effluent, Manhole at 48th & Lawton Streets	9/16/76	5.4
		9/17/76	4.3
		9/18/76	8.1
		9/19/76	5.6
		9/20/76	4.0
		9/21/76	6.4
		9/22/76	7.5
		9/23/76	7.9
		9/24/76	6.3
31	Land's End, approximately 100 meters SE of Effluent Outfall and 50 meters offshore	9/15/76	80*
		9/16/76	80
		9/17/76	1.0
		9/18/76	80
		9/19/76	80
		9/20/76	80
		9/21/76	80
		9/22/76	<1.0
		9/23/76	<1.0
		9/24/76	<1.0
32	Land's End, approximately 200 meters off axis to direct line with the Richmond-Sunset outfall	9/15/76	80
		9/16/76	80
		9/17/76	80
		9/18/76	80
		9/19/76	80
		9/20/76	80
		9/21/76	80
		9/22/76	<1.0
		9/23/76	<1.0
		9/24/76	<1.0

* All = Not detected

Table 8

[illegible][1]
[illegible]
September 1975

Station Number	Depth	Date Sampled 9/15/75	9/16/75	9/17/75	9/18/75
31	Surface (-0.5m)	0.01	ND [1]	0.01	ND
32	9m	0.01	ND	ND	ND
33	Surface (-0.5m)	0.01	ND	0.01	ND
35	Surface (-0.5m)	ND	ND	ND	0.01
36	16m	ND	ND	ND	0.01

1 *[illegible]*
11 *None detected*

Table 8

SUMMARY OF VIOLATIONS OF BACTERIOLOGICAL LIMITATIONS
15-21 September '75

Station Number	Station Description	Date	Total Coliforms (MPN/100 ml)	Fecal Coliforms (MPN/100 ml)
Richmond Local				
43	Baker Beach (North End), Approximately 50 meters offshore	9/19/75		540[III]
45	Ocean Beach, Approximately 300 meters offshore, adjacent to Fulton Street	9/15-24/75	280[I]	110[II]
		9/17/75		490[III]
47	Ocean Beach, Approximately 300 meters offshore, adjacent to Lincoln Park	9/15-24/75	610[I]	75[II]
North Point				
11	North Point Plant Effluent @ East Jetty Junction Building	9/15-24/75	2,000,000[I]	770,000[III]
		9/15/75	2,400,000[III]	
		9/16/75	2,300,000[III]	
		9/17/75	2,300,000[III]	
		9/18/75	430,000[III]	
		9/19/75	2,300,000[III]	
		9/20/75	2,000,000[III]	
		9/21/75	13,000,000[III]	
		9/22/75	1,700,000[III]	
		9/23/75	1,400,000[III]	
		9/24/75	1,300,000[III]	
13	San Francisco Bay @ end of Pier 33	9/21/75		1,600[III]
15	San Francisco Bay @ Approximately 300 meters from end of Pier 33	9/21/75		820[III] 2,100[III]
25	San Francisco Bay, Approximately 600 meters from end of Pier 39	9/21/75		17,400[III]
Southeast				
01	Southeast Effluent @ Control Pump	9/15-24/75	1,600[I]	
		9/16/75	2,400,000[III]	
		9/17/75	11,000[III]	
		9/18/75	28,000[III]	
		9/20/75	17,000[III]	
05	San Francisco Bay, Approximately 600 meters from end of Pier 80	9/21/75		970[III]

[I] [illegible]
[II] [illegible]
[III] [illegible]

[I] [illegible]
[II] [illegible]
[III] [illegible]

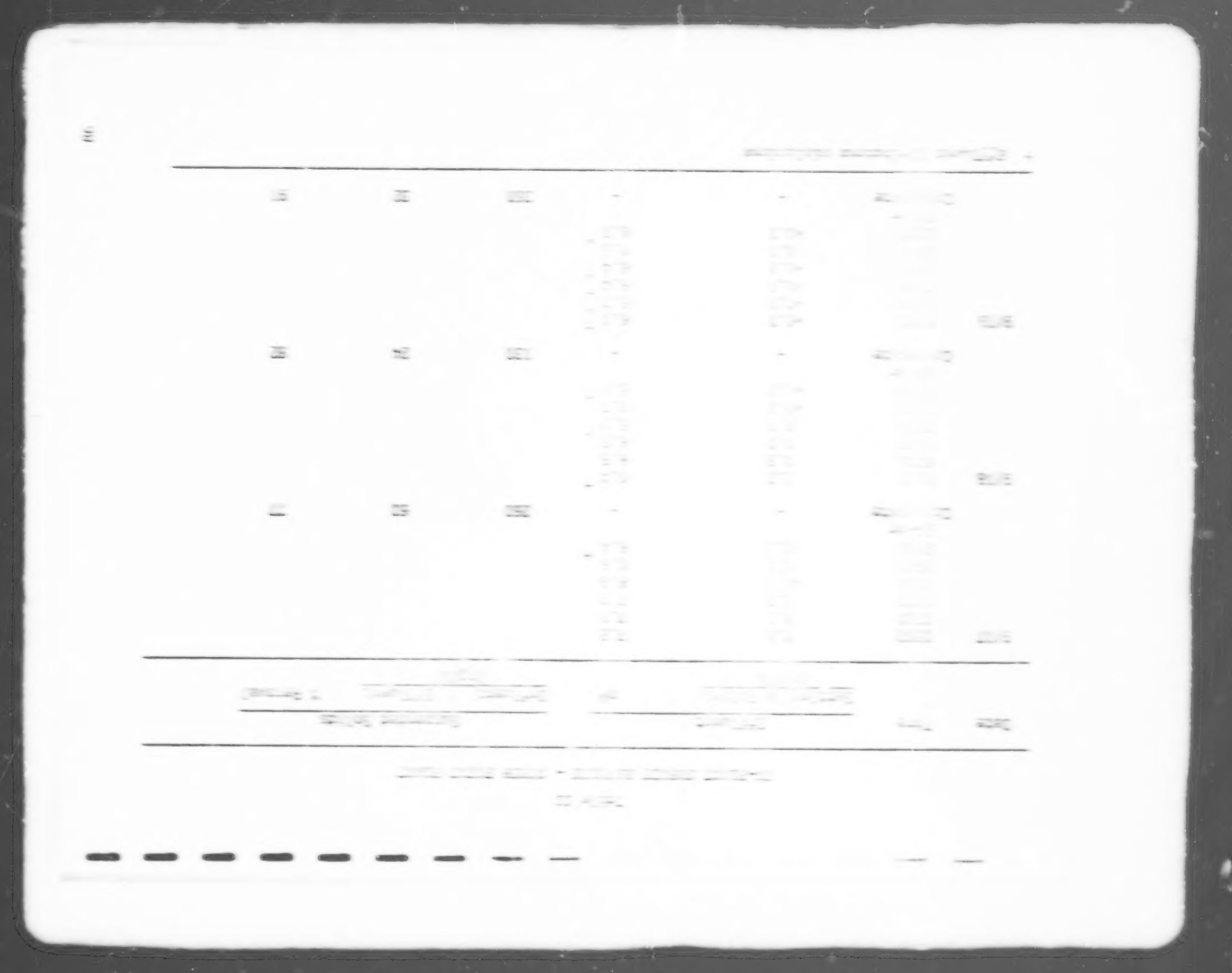

Table 18

BELT-THICKENING DATA - NORTH POINT PLANT

Date: 1971	Settleable Solids (ml/l) Avg. of 6/Day			pH			Suspended Solids Removal (%)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	0	0.02	0.19	6.2	6.8	7.2	49	69	82
Feb.	0	0.02	0.1	6.1	6.7	7.1	30	67	86
Mar.	0	0.05	0.22	6.2	6.7	8.3	21	61	78
Apr.	0	0.02	0.12	6.5	6.8	8.2	41	64	85
May	0	0.02	0.22	6.5	6.9	8.2	61	73	83
June	0	0.01	0.10	6.5	6.8	8.7	61	73	83
July	0	0.03	0.10	6.2	6.7	6.9	54	72	87
Aug.	0	0.1	0.08	6.5	6.7	7.0	64	72	86
Sept.	-	-	-	-	-	-	61	74	86

Table 18

IRON ANALYSES, SOUTH POINT PLANT

Date	Time	Iron (mg/l) After Iron Addition	Iron (mg/l) Before Iron Addition	Amount of Iron Added
9/17	1300	10.10	1.58	8.52
	1500	9.11	2.04	7.07
	1700	11.80	1.61	10.19
	1900	9.72	1.34	8.38
	2100	13.60	1.32	12.28
	2300	7.21	4.02	3.19
9/18	0900	8.61	1.25	7.36
	1100	4.02	1.58	2.44
	1300	4.57	1.71	2.86
	1500	8.05	1.46	6.59
	1700	9.76	1.89	7.87
	1900	6.37	1.37	5.0
	2100	5.46	1.31	4.15
	2300	5.69	1.74	3.99
9/19	0900	8.52	1.31	7.21
	1100	3.43	1.87	1.56
	1300	4.27	1.83	2.44
	1500	7.45	1.91	5.54
	1700	8.04	5.10	2.94
	1900	8.26	1.46	6.80
	2100	5.17	1.30	3.87
	2300	8.56	3.36	5.20
				Avg = 5.70[1]

1 5.70 mg/l iron is equivalent to 18.0 mg/l ferric chloride.

Table 14

RESIDUAL CHLORINE CONCENTRATION
NORTH POINT PLANT EFFLUENT AND RECEIVING WATERS
September 1976

Station Number	Station Description	Date	Residual Cl_2 mg/l
11	North Point Plant Effluent at Collection Basin	9/16/76	2.1
		9/17/76	5.1
		9/18/76	4.0
		9/19/76	2.1
		9/20/76	4.9
		9/21/76	2.4
		9/22/76	3.3
		9/23/76	4.5
		9/24/76	5.7
13	San Francisco Bay at the end of Pier 33	9/15/76	ND*
		9/16/76	ND
		9/17/76	<1.0
		9/18/76	<1.0
		9/19/76	<1.0
		9/20/76	<1.0
		9/21/76	<1.0
		9/22/76	<1.0
		9/23/76	<1.0
		9/24/76	<1.0
21	San Francisco Bay at the end of Pier 35	9/15/76	<1.0
		9/16/76	<1.0
		9/17/76	<1.0
		9/18/76	<1.0
		9/19/76	<1.0
		9/20/76	<1.0
		9/21/76	<1.0
		9/22/76	<1.0
		9/23/76	<1.0
		9/24/76	<1.0

* None Detected

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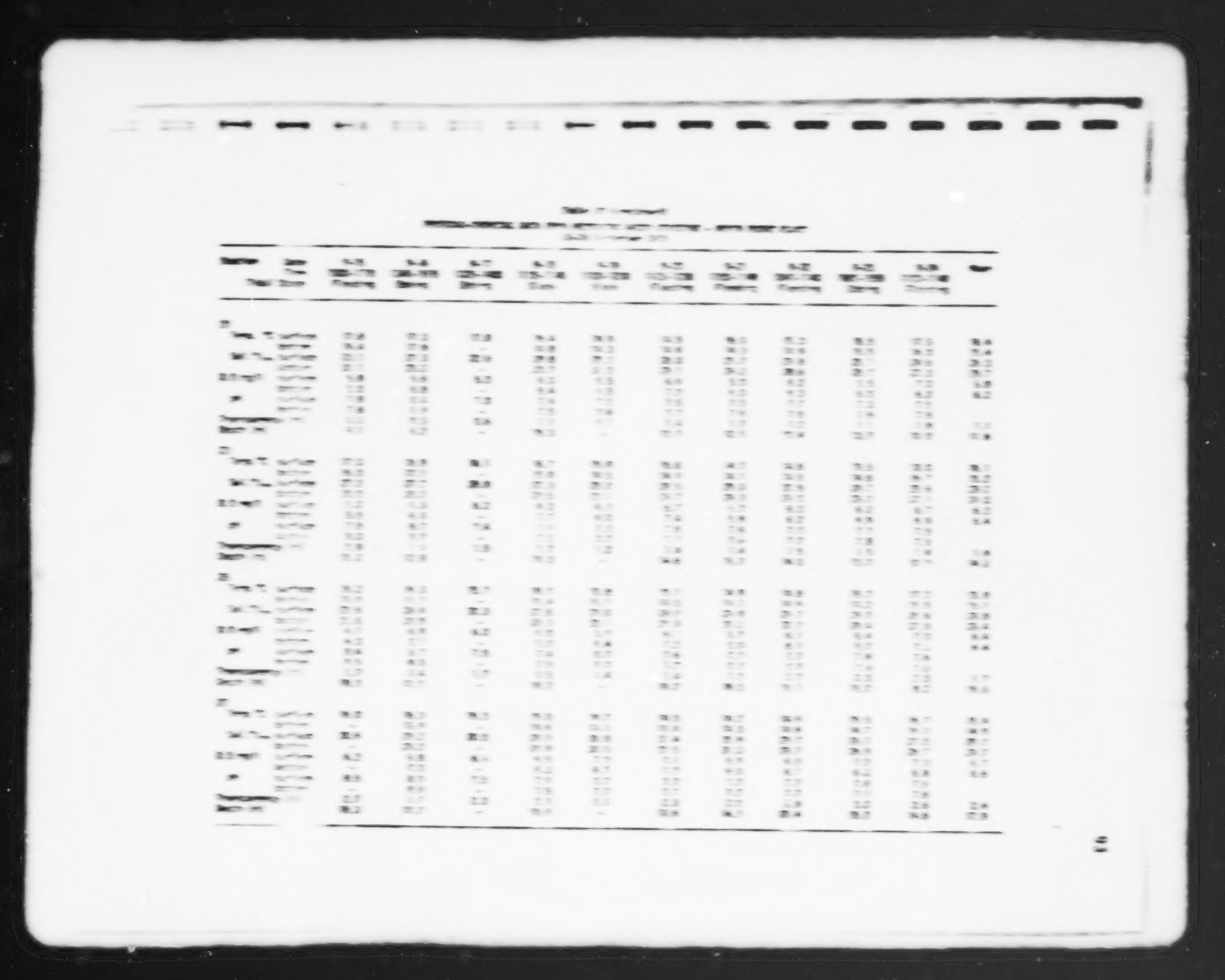


Table 18

DISSOLVED SULFIDES[1]
NORTH POINT PLANT
September 1976

Station Number	Depth	Date Sampled 9/15/76	9/16/76	9/17/76	9/18/76
13	Surface (-0.5m)	.02	.04	.01	.02
15	Surface (-0.5m)	ND[1,1]	.04	.01	.02
16	12 m	ND	.05	ND	ND
17	Surface (-0.5m)	ND	.08	.01	.01
18	12m	ND	.08	ND	ND
19	Surface (-0.5m)	ND	.08	.01	.01
20	16m	ND	.08	ND	ND
21	Surface (-0.5m)	ND	.08	.01	.02
22	9m	ND	.09	ND	ND
23	Surface (-0.5m)	ND	.08	.01	.02
24	13m	ND	.08	ND	ND
25	Surface (-0.5m)	ND	ND	.01	.02
27	Surface (-0.5m)	ND	ND	.01	.01

[1] Amounts in mg/l
[1,1] None detected

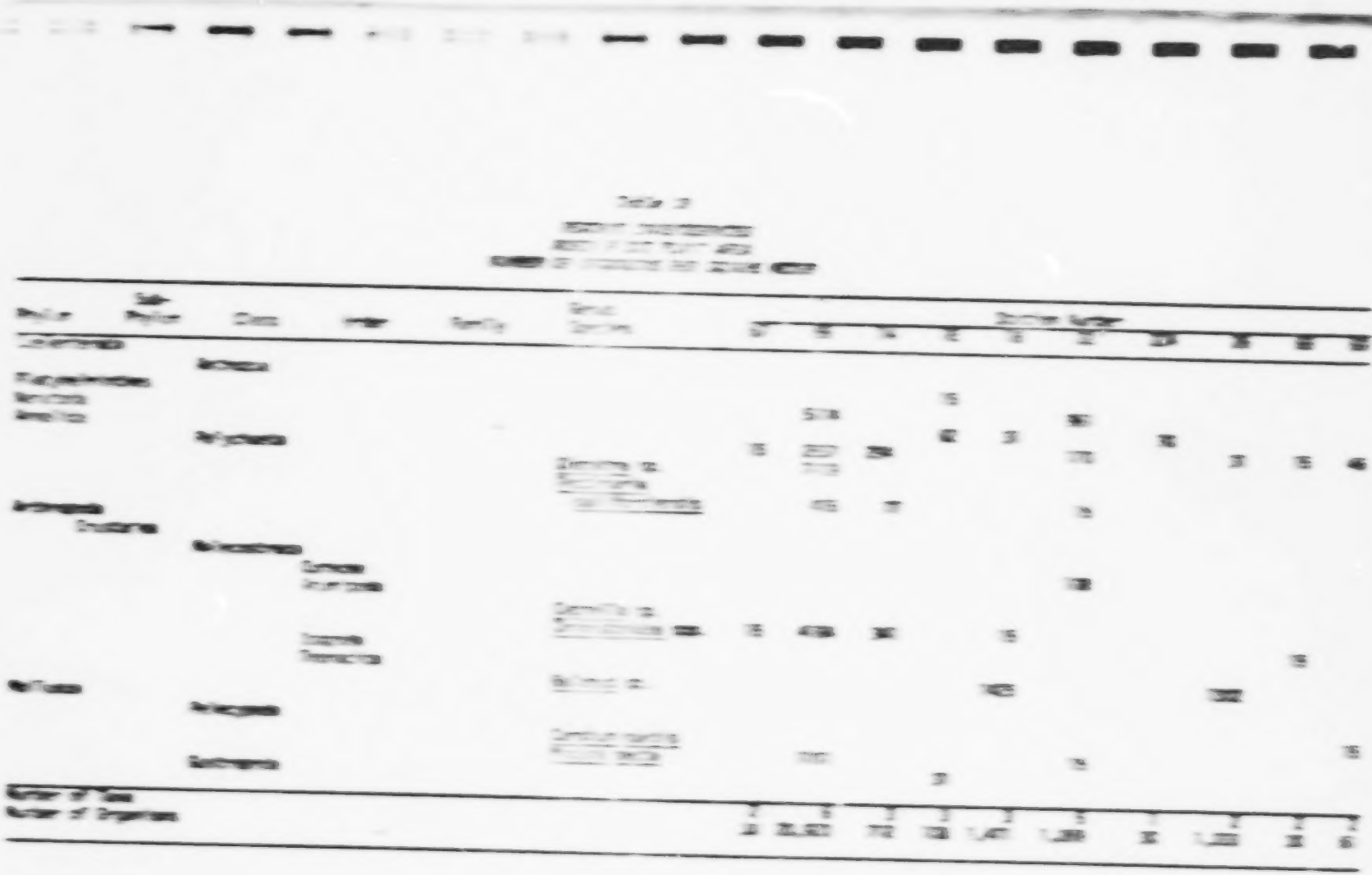


Table 80

IRON ANALYSES, DONIPHAN PLANT

Date	Time	Iron (mg/l) After Iron Addition	Iron (mg/l) Before Iron Addition	Amount of Iron Added
9/17	0900	13.7	2.50	11.20
	1100	13.0	2.97	10.03
	1300	14.5	2.90	11.60
	1500	16.0	3.27	12.73
	1700	14.5	2.87	11.66
	1900	12.9	2.08	10.52
	2100	14.0	2.13	11.87
	2300	13.1	1.61	11.49
9/18	0900	15.3	4.03	11.27
	1100	15.1	3.63	11.47
	1300	18.1	8.57	9.53
	1500	15.0	3.37	11.63
	1700	14.2	2.40	11.80
	1900	13.5	2.02	11.48
	2100	14.4	2.36	12.04
	2300	13.4	1.68	11.82
9/19	0900	14.4	3.13	11.27
	1100	17.1	5.50	11.62
	1300	15.5	3.27	12.23
	1500	15.2	3.04	12.16
	1700	24.3	15.2	9.10
	1900	14.3	2.62	11.68
	2100	13.2	1.86	11.34
	2300	14.7	1.60	13.10
				Avg = 11.44[1]

[1] 11.44 mg/l iron is equivalent to 38.10 mg/l ferric chloride

| | | |

Table 33

BELLINGHAM DATA - NORTHSIDE PLANT

Date 1975	Settleable Solids (ml/l) Avg. of 6/Day			pH			Suspended Solids Removal (%)		
	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
Jan.	0	0.02	0.30	6.0	6.6	7.5	21	67	80
Feb.	0	0.04	0.21	4.7	6.7	7.7	35	52	66
Mar.	0	0.03	0.22	4.9	6.5	6.9	0	47	80
Apr.	0	0.03	0.10	6.5	6.7	7.0	37	57	77
May	0	0.03	0.13	6.0	6.4	6.7	40	65	82
June	0	0.05	0.22	6.7	6.5	6.7	15	58	79
July	0	0.03	0.25	6.1	6.6	7.0	21	60	77
Aug.	0	0.04	0.02	6.0	6.0	6.0	20	59	80
Sept.	-	-	-	-	-	-	43	64	83

Table 23

RESIDUAL CHLORINE CONCENTRATION
NORTHEAST FLOAT EFFLUENT AND RECEIVING WATERS
September 1975

Station Number	Station Description	Date	Residual Cl_2 (mg/l)
01	Southeast Plant effluent at Booster pump wet well	9/16/75	3.3
		9/17/75	5.5
		9/18/75	7.2
		9/19/75	5.7
		9/20/75	3.3
		9/21/75	4.9
		9/22/75	6.6
		9/23/75	7.2
		9/24/75	4.9
03	San Francisco Bay, at the end of the Army Street Terminal	9/16/75	ND[1]
		9/16/75	ND
		9/17/75	ND
		9/18/75	ND
		9/19/75	ND
		9/20/75	ND
		9/21/75	ND
		9/22/75	<1.0
		9/23/75	<1.0
		9/24/75	<1.0
05	San Francisco Bay, approximately 200 meters offshore at the end of the Army Street Terminal	9/16/75	ND
		9/16/75	ND
		9/17/75	ND
		9/18/75	ND
		9/19/75	ND
		9/20/75	ND
		9/21/75	ND
		9/22/75	<1.0
		9/23/75	<1.0
		9/24/75	<1.0

[1] None detected

| | | |

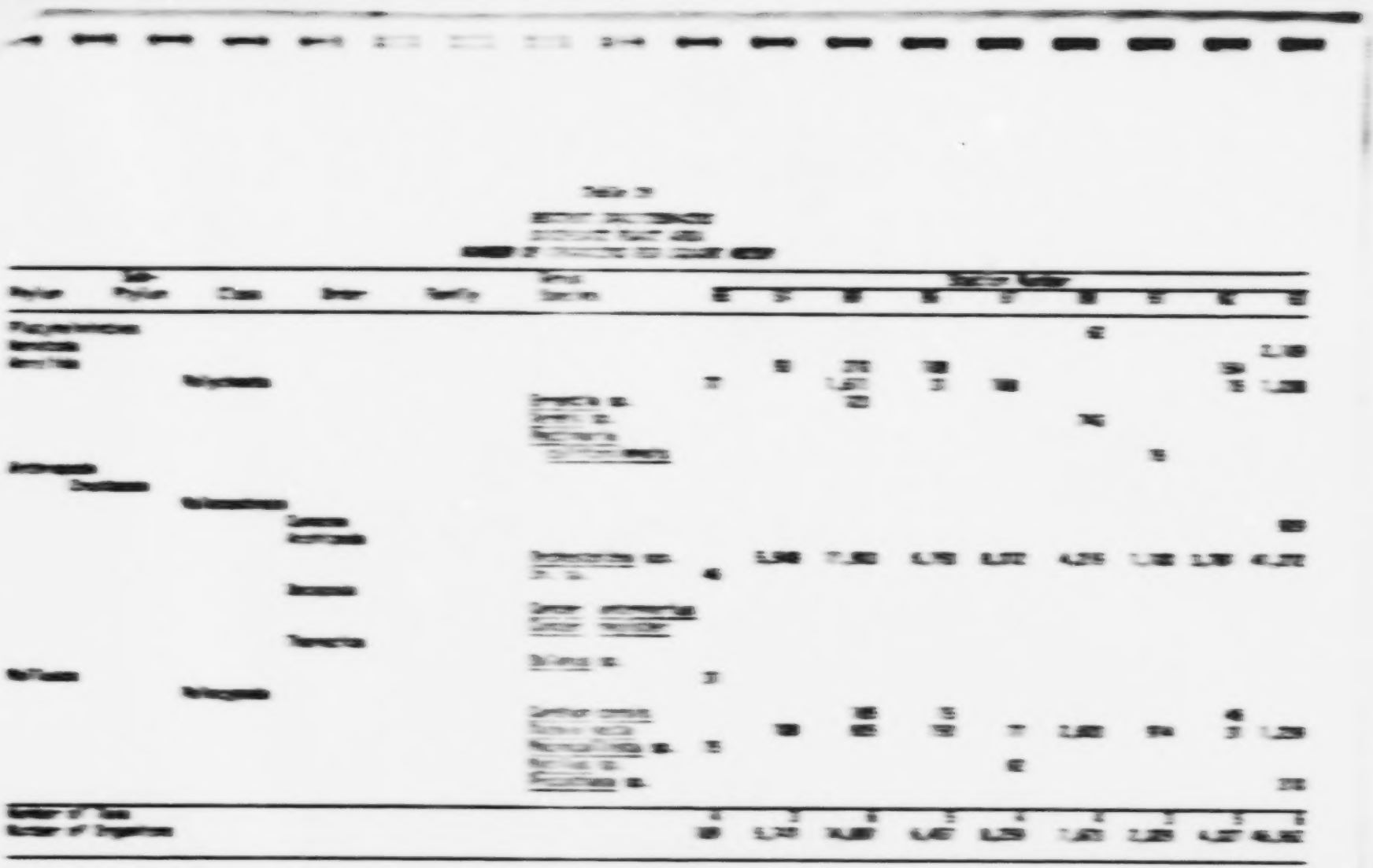
[illegible]

Table 5F

DISSOLVED SULFIDES[1]
BRAIDWOOD PLANT
September 1975

Station Number	Depth	9/10/75	Date Sampled 9/12/75	9/17/75	9/18/75
4	Surface (-0.5m)	.01	.01	.01	.01
	11 m	.01	.01	ND	ND
5	Surface (-0.5m)	.01	.02	.01	.01
	19 m	.02	.02	ND	ND
6	Surface (-0.5m)	.01	.01	.01	.02
	19 m	.02	.02	ND	ND

1 Amounts in mg/l
ND None detected



APPENDIX B
METHODS

METHODS

IN-PLANT SURVEY

Sample locations at Richmond-Sunset, North Point and Southeast Water Pollution Control Plants were selected so that the efficiency of removal of suspended solids could be determined. Samples of the influent and effluent were collected every 2 hours and composited over 24 hours according to flow. Sampling at all plants began at 0100 hours on 17 September 1975 and was concluded at 2300 hours on 19 September 1975. All composited wastewater samples were returned under chain-of-custody procedures (Appendix C) to the NEIC laboratories in Denver, Colorado for suspended solids analysis. Suspended solids were determined by the procedure described in the *EPA Manual* (1974).[1]

Every 4 hours during the in-plant surveys, a grab sample of the final effluent was taken (downstream from the point at which chlorine was added). Temperature, pH and settleable solids concentration were determined at the site on each of these samples. Temperature, as measured with a standard centigrade thermometer, was determined for the sole purpose of calibrating the pH meters. Settleable solid determinations were made according to procedures described in *Standard Methods*.[1]

Richmond-Sunset Plant

With the help of the plant staff, a 90° weir box was installed in the discharge channel of the first stage elutriation tank. This installation enabled calculation of the volume of the elutriate being returned to the main stream. Based on this calculation, a daily flow-proportional sample of the elutriation return was taken every 2 hours from 0100 on 17 September to 2300 on 19 September.

A representative daily composite sample of the thickening tank supernatant was collected by taking a 25 ml grab sample when pumping first began and another 25 ml grab sample as the level in the thickening tank dropped 15 cm (6 in). This procedure of collecting a 25 ml sample every 15 cm was continued until pumping was stopped. This sampling procedure was followed every other time the pumping of supernatant was initiated.

North Point Plant

As part of the North Point plant treatment process, ferric chloride and an anionic polymer were added to the main stream from 0700 to 2400 hours each day during the survey. During the time the chemicals were added, approximately 9,265 m^3/day (1,700 gpm) of Bay water was added to the influent to enhance the effect of the chemicals. According to the chief chemist of the North Point plant, the pumping rate of chemicals was flow-controlled and the pumps and controls were set to maintain a ferric chloride addition rate of 15 mg/l (as $FeCl_3$). Grab samples of the influent and of the flow as it entered the east sump (after $FeCl_3$ addition) were taken every 2 hours in pre-acidified bottles and sent to the NEIC laboratories for iron analysis. The purpose of this procedure was to enable measurement of how closely the chemical addition rate was being controlled. Total iron was determined by the Atomic Absorption procedure described in the *EPA Manual* (1974).[1]

Southeast Plant

At the Southeast plant, ferric chloride and an anionic polymer were added to the main stream 24 hours per day. The control equipment was set to maintain the ferric chloride addition rate at 30 mg/l (as $FeCl_3$). Grab samples of influent and of the main stream as it entered the grit tank were taken every 2 hours from 0900 to 2300 in pre-acidified bottles and returned to the NEIC laboratories for iron analysis.

To determine the contribution of suspended solids in the sludge handling return stream, a flow-proportional composite sample was taken every 8 hours. The flow rate was determined by measuring the depth of flow in the return pipe and determining its velocity at quarter-points with a Marsh-McBirney* flow meter.

BACTERIOLOGY

Analysis of total and fecal coliform bacteria were performed using the most probable number procedure according to standard techniques.[1] Using aseptic techniques, all samples were collected in sterile bottles prepared by the accepted procedure.

Sampling for *Salmonella* involved two separate procedures. For effluent sampling, sterile gauze pads were placed in the discharge for 3-5 days. The pads were retrieved aseptically, placed in sterile plastic bags, chilled and transported to the laboratory within 3 hours for analyses. In the case of receiving water samples, large volume samples (30 liters) were collected aseptically according to accepted procedures.

There is no standard procedure for the detection of *Salmonella* in surface waters. The methods employed by NEIC are a combination of those present in *Standard Methods*[1] and methods developed by the NEIC bacteriology staff. Large volume samples were vacuum filtered through sterile Balston® Grade AA micro-fiber filter tube elements in sterile Balston filter assemblies. After filtration, the filter elements were shredded aseptically. Filter emulsions and gauze pads were placed in containers of selective enrichment media consisting of dulcitol-selenite broth and incubated at 41.5°C (107°F). On each of four successive days, the growths in the enrichment media containing the pads or the filter

* Mention of brand names does not imply endorsement by EPA.

emulsions were streaked onto selective plates of xylose-lysine-deoxycholate agar. After a 24-hour incubation period at 35°C (95°F) the plates were examined for colonies with characteristics typical of *Salmonella*. Typical colonies were picked from the plates and subjected to biochemical and serological identification.

BIOASSAY

The static bioassay was used to test toxicity response of the threespine stickleback (25-35 mm, total length) to dilutions of the San Francisco wastewater treatment plant effluents.

Test organisms were obtained from the Ales Fish Company, San Rafael, California. The bioassays were short term (96-hour) tests which measured acute toxicity by means of percent survival. The procedure used in these tests is described in *Standard Methods for the Examination of Water and Wastewater*.[1]

Before the start of the bioassay, each container was filled with fresh San Francisco Bay water collected near shore at the Presidio, and a volume of effluent sample was added to selected containers to produce the desired dilution. A typical bioassay contained a control and four effluent dilutions in duplicate. Three consecutive replicates were tested.

Once the proper dilutions had been prepared, ten test fish were carefully transferred from the large holding tank into each 8 liter glass test aquarium. Next the pH, dissolved oxygen, temperature, residual chlorine and salinity were measured in each aquarium. These parameters, with the exception of residual chlorine and salinity, were measured daily and recorded as were the number of surviving fish. At

each check all dead specimens were removed. If the dissolved oxygen was below 5.0 mg/l at the start of a test or during a test, aeration was begun.

The LC50 values were estimated using graphic interpolation.

CHEMISTRY

With the exception of dissolved oxygen, all field measurements of the receiving waters were made aboard the survey vessels. Dissolved oxygen analyses were performed with a galvanic DO probe in the field laboratory and routinely checked by Winkler titrations. Methods of analyses conformed to those prescribed in *Standard Methods*.[1]

An inductive-conductive instrument combined with a Wheatstone bridge-type thermocouple was used for salinity and temperature determinations. The pH meters used were glass electrode type and were frequently calibrated with standard buffer solutions.

Samples for residual chlorine were performed at the NCIC Mobile Laboratory by the iodometric method described in *Standard Methods*.[1]

Samples for total sulfide concentration were analyzed at the NCIC Mobile Laboratory by the Methylene Blue Photometric Method described in *Standard Methods*.[1]

OYSTER EXPOSURE TESTS

Seed and yearling oysters (*Crassostrea gigas*) were collected from a commercial shellfish grower at Drakes Estero, California. These Pacific oysters were used for the exposure studies conducted in San Francisco Bay during October 1975.

Five to seven clusters of yearling oysters and three to four cultch shells containing seed oysters were strung on a wire or nylon line; oyster clusters were separated by a piece of hard plastic tubing (about 10 cm or 4 in long). At selected stations, the line-strung clusters of oysters were suspended so the oysters were submerged 1 to 3 m (3 to 10 ft) underwater. After 5-1/2 days of exposure (considered to be the minumum time required for juvenile oysters to respond to environmental conditions), the oysters were retrieved and examined to determine mortality. Also, the yearling oysters were shucked to inspect the texture and odor of the tissues.

BENTHOS

At Land's End near the Richmond Sunset discharge, qualitative benthos collections were made by hand-sampling. Station 32 consisted of a transect directly offshore from and parallel to the discharge. Here, divers examined all available habitats and collected invertebrates by hand. Organisms collected at Station 32 were preserved in 90% ethanol. Stations 30, 70, 71 and 72 were located in the intertidal zone from the discharge northeast. In this area, divers waded into the surf, examined all available habitats, and collected organisms by hand. Benthos samples from the Land's End intertidal zone were preserved in 10% formalin solutions.

Quantitative samples of benthic invertebrates were collected in the areas of the North Point and Southeast plant discharges. At these locations, sediments were raised from the bottom by a Petersen grab, deposited in a bucket, and examined for consistency, and the presence or absence of sludge. Samples were then washed through a U.S. Standard No. 30 sieve, and retained organisms and debris were preserved in the 10% formalin solutions.

In the laboratory, benthic samples were examined, separated from debris, sorted, identified and counted. Densities of benthic organisms were expressed as numbers of organisms per square meter.

Sediments

In the vicinity of the Southeast plant outfall, sediment samples were collected by divers using transparent coring tubes, 3 cm (1.1 in) in diameter. The top 10 cm (3 in) of sediment was removed from the core, examined, and preserved on wet ice.

APPENDIX C
CHAIN OF CUSTODY PROCEDURES

ENVIRONMENTAL PROTECTION AGENCY
Office Of Enforcement
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Building 53, Box 25227, Denver Federal Center
Denver, Colorado 80225

July 24, 1974

CHAIN OF CUSTODY PROCEDURES

General:

The evidence gathering portion of a survey should be characterized by the minimum number of samples required to give a fair representation of the effluent or water body from which taken. To the extent possible, the quantity of samples and sample locations will be determined prior to the survey.

Chain of Custody procedures must be followed to maintain the documentation necessary to trace sample possession from the time taken until the evidence is introduced into court. A sample is in your "custody" if:

1. It is in your actual physical possession, or
2. It is in your view, after being in your physical possession, or
3. It was in your physical possession and then you locked it up in a manner so that no one could tamper with it.

All survey participants will receive a copy of the survey study plan and will be knowledgeable of its contents prior to the survey. A pre-survey briefing will be held to re-appraise all participants of the survey objectives, sample locations and Chain of Custody procedures. After all Chain of Custody samples are collected, a de-briefing will be held in the field to determine adherence to Chain of Custody procedures and whether additional evidence type samples are required.

Sample Collection:

1. To the maximum extent achievable, as few people as possible should handle the sample.
2. Stream and effluent samples shall be obtained, using standard field sampling techniques.
3. Sample tags (Exhibit I) shall be securely attached to the sample container at the time the complete sample is collected and shall contain, at a minimum, the following information: station number, station location, date taken, time taken, type of sample, sequence number (first sample of the day - sequence No. 1, second sample - sequence No. 2, etc.), analyses required and samplers. The tags must be legibly filled out in ballpoint (waterproof ink).

Chain of Custody Procedures (Continued)

Sample Collection (Continued)

4. Blank samples shall also be taken with preservatives which will be analyzed by the laboratory to exclude the possibility of container or preservative contamination.

5. A pre-printed, bound Field Data Record logbook shall be maintained to record field measurements and other pertinent information necessary to refresh the sampler's memory in the event he later takes the stand to testify regarding his action's during the evidence gathering activity. A separate set of field notebooks shall be maintained for each survey and stored in a safe place where they could be protected and accounted for at all times. Standard formats (Exhibits II and III) have been established to minimize field entries and include the date, time, survey, type of samples taken, volume of each sample, type of analysis, sample numbers, preservatives, sample location and field measurements such as temperature, conductivity, DO, pH, flow and any other pertinent information or observations. The entries shall be signed by the field sampler. The preparation and conservation of the field logbooks during the survey will be the responsibility of the survey coordinator. Once the survey is complete, field logs will be retained by the survey coordinator, or his designated representative, as a part of the permanent record.

6. The field sampler is responsible for the care and custody of the samples collected until properly dispatched to the receiving laboratory or turned over to an assigned custodian. He must assure that each container is in his physical possession or in his view at all times, or locked in such a place and manner that no one can tamper with it.

7. Colored slides or photographs should be taken which would visually show the outfall sample location and any water pollution to substantiate any conclusions of the investigation. Written documentation on the back of the photo should include the signature of the photographer, time, date and site location. Photographs of this nature, which may be used as evidence, shall also be handled recognizing Chain of Custody procedures to prevent alteration.

Transfer of Custody and Shipment:

1. Samples will be accompanied by a Chain of Custody Record which includes the name of the survey, samplers signatures, station number, station location, date, time, type of sample, sequence number, number of containers and analyses required (Fig. IV). When turning over the possession of samples, the transferor and transferee will sign, date and time it sheet. This record sheet

Chain of Custody Procedures (Continued)

allows transfer of custody of a group of samples in the field, to the mobile laboratory or when samples are dispatched to the NEIC - Denver laboratory. When transferring a portion of the samples identified on the sheet to the field mobile laboratory, the individual samples must be noted in the column with the signature of the person relinquishing the samples. The field laboratory person receiving the samples will acknowledge receipt by signing in the appropriate column.

2. The field custodian or field sampler, if a custodian has not been assigned, will have the responsibility of properly packaging and dispatching samples to the proper laboratory for analysis. The "Dispatch" portion of the Chain of Custody Record shall be properly filled out, dated, and signed.

3. Samples will be properly packed in shipment containers such as ice chests, to avoid breakage. The shipping containers will be padlocked for shipment to the receiving laboratory.

4. All packages will be accompanied by the Chain of Custody Record showing identification of the contents. The original will accompany the shipment, and a copy will be retained by the survey coordinator.

5. If sent by mail, register the package with return receipt requested. If sent by common carrier, a Government Bill of Lading should be obtained. Receipts from post offices and bills of lading will be retained as part of the permanent Chain of Custody documentation.

6. If samples are delivered to the laboratory when appropriate personnel are not there to receive them, the samples must be locked in a designated area within the laboratory in a manner so that no one can tamper with them. The same person must then return to the laboratory and unlock the samples and deliver custody to the appropriate custodian.

Laboratory Custody Procedures:

1. The laboratory shall designate a "sample custodian." An alternate will be designated in his absence. In addition, the laboratory shall set aside a "sample storage security area." This should be a clean, dry, isolated room which can be securely locked from the outside.

2. All samples should be handled by the minimum possible number of persons.

3. All incoming samples shall be received only by the custodian, who will indicate receipt by signing the Chain of Custody Record sheet

Chain of Custody Procedures (Continued)

accompanying the samples and retaining the sheet as permanent records. Couriers picking up samples at the airport, post office, etc. shall sign jointly with the laboratory custodian.

4. Immediately upon receipt, the custodian will place the sample in the sample room, which will be locked at all times except when samples are removed or replaced by the custodian. To the maximum extent possible, only the custodian should be permitted in the sample room.

5. The custodian shall ensure that heat-sensitive or light sensitive samples, or other sample materials having unusual physical characteristics, or requiring special handling, are properly stored and maintained.

6. Only the custodian will distribute samples to personnel who are to perform tests.

7. The analyst will record in his laboratory notebook or analytical worksheet, identifying information describing the sample, the procedures performed and the results of the testing. The notes shall be dated and indicate who performed the tests. The notes shall be retained as a permanent record in the laboratory and should note any abnormalities which occurred during the testing procedure. In the event that the person who performed the tests is not available as a witness at time of trial, the government may be able to introduce the notes in evidence under the Federal Business Records Act.

8. Standard methods of laboratory analyses shall be used as described in the "Guidelines Establishing Test Procedures for Analysis of Pollutants," 38 F.R. 28758, October 18, 1973. If laboratory personnel deviate from standard procedures, they should be prepared to justify their decision during cross-examination.

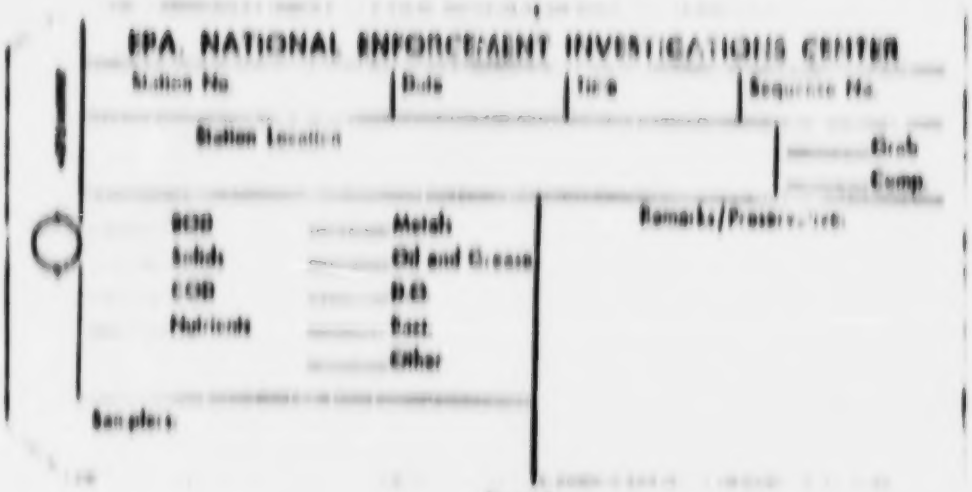
9. Laboratory personnel are responsible for the care and custody of the samples once it is handed over to them and should be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the tests were run.

10. Once the sample testing is completed, the unused portion of the sample together with all identifying tags and laboratory records, should be returned to the custodian. The returned tagged sample will be retained in the sample room until it is required for trial. Strip charts and other documentation of work will also be turned over to the custodian.

Chain of Custody Procedures (Continued)

11. Samples, logs and laboratory records of tests may be destroyed only upon the order of the laboratory director, who will first confer with the Chief, Enforcement Specialist Office, to make certain that the information is no longer required or the samples have deteriorated.

EXHIBIT I



Front

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
BUILDING 53, BOX 25227, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

Back

ANALYSIS REQUIRED	TOTAL VOLUME	TYPE CONTAINER
HYDROCARBONS		
BOD		
COD		
TOC		
TOTAL METALS		
DISSOLVED METALS		
ALKALINITY		
DO		
pH		
CHLORIDE DEMAND		
TEMPERATURE		
TOTAL COLIFORM		
FECAL COLIFORM		
TURBIDITY		
OIL AND GREASE		
NITRATE		
BACTERIA		
PESTICIDES		
TDS		
TRACE ORGANICS		
PHENOLS		
CYANIDE		

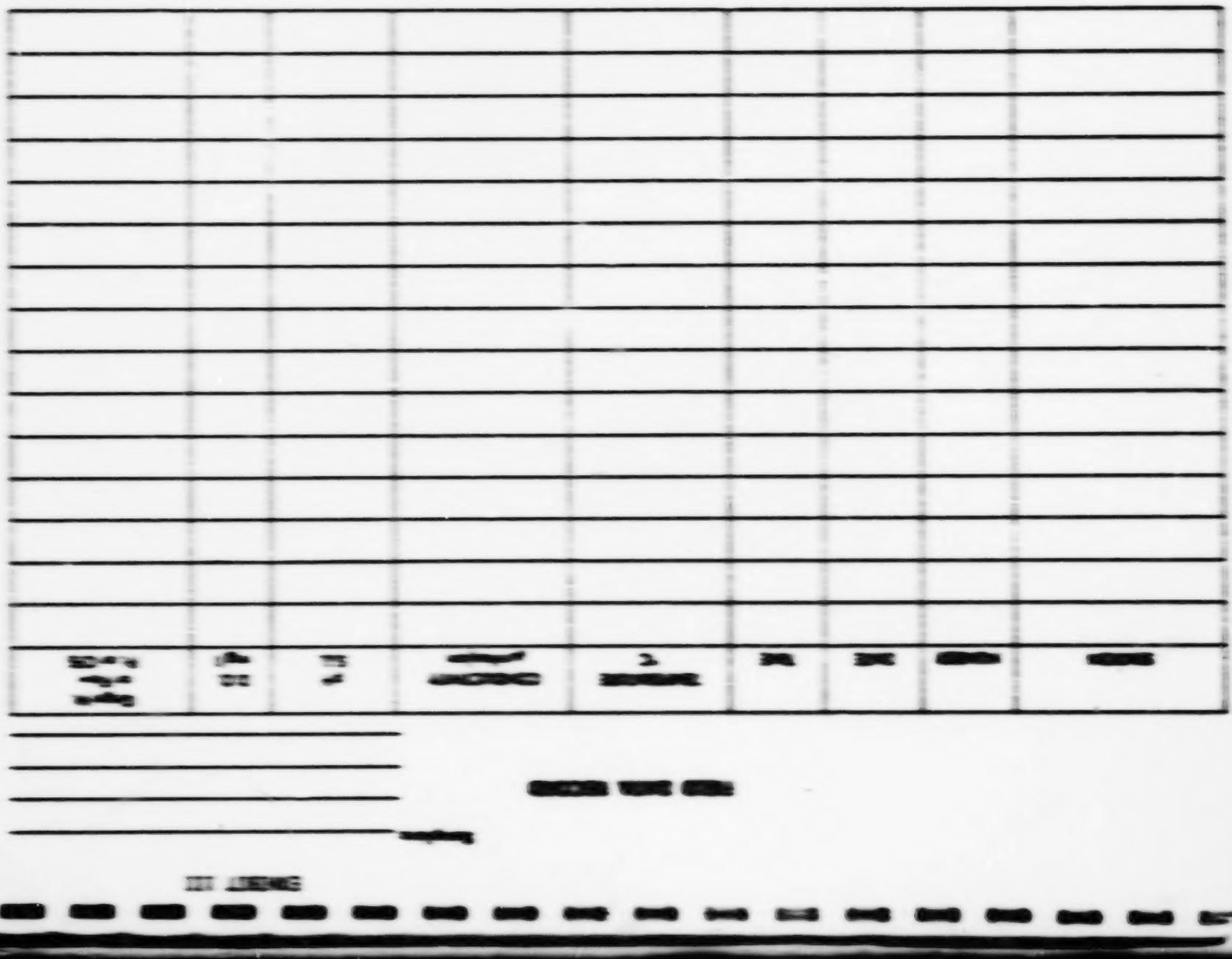


EXHIBIT IV

ENVIRONMENTAL PROTECTION AGENCY
Office Of Enforcement
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Building 53, Box 25227, Denver Federal Center
Denver, Colorado 80225

CHAIN OF CUSTODY RECORD

SURVEY

SAMPLERS: (Signature)

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE: Matrix (Comp / Grab)	SAMPLE TYPE: Air	SEQ NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED

Relinquished by: (Signature) — Received by: (Signature) — Date/Time

Relinquished by: (Signature) — Received by: (Signature) — Date/Time

Relinquished by: (Signature) — Received by: (Signature) — Date/Time

Relinquished by: (Signature) — Received by Mobile Laboratory for field analysis: (Signature) — Date/Time

Dispatched by: (Signature) — Date/Time — Received for Laboratory by: — Date/Time

Method of Shipment:

Distribution: Orig - Accompany Shipment
1 Copy - Survey Coordinator Field Files

Supplement to *Evaluation of Sewage Treatment Facilities*
DISCHARGES OF HEAVY METALS AT THE SOUTHEAST PLANT

Special studies were conducted in September 1975 by the EPA at the Southeast Water Pollution Control Plant to determine the presence and evaluate the impact of heavy metals discharges.

Copper was found in toxic concentrations of 0.05 mg/l* in the Plant effluent and in the Bay near to the plant outfall [Table 1]. Individually, none of the other metal concentrations exceeded known toxic levels; however, chromium concentrations were of concern. The 1.88 mg/l of chromium found in the plant effluent on 18 September 1975 approached the value of 1.8 mg/l Cr known to be acutely toxic to threespine stickleback.**

Zinc and cadmium concentrations were considered important also because these metals act synergistically to increase toxicity. Specifically, the combination of 0.170 mg/l of zinc and 0.056 mg/l of cadmium recorded in the Bay at Station B on 17 September 1975 has been reported to cause mortality of marine fish.***

Concentrations of the heavy metals (chromium, lead and zinc) in sediments were higher at locations near the mouth of Islais Creek (Station B4), near the diffuser (Station B5) and under the effluent plume (Station F4) than at other points outside the immediate discharge or bypass areas

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* U. S. Department of Interior. 1968. Water Quality Criteria. Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D. C. April. 234 p.

** Herbrock, H. H., Industrial Wastes. 1958. Some Data on Toxicity of Metals in Wastes to Fish Life are Presented. Ind. Eng. Chem. 50, 884.

*** Rubiow, W. P., Wood, J. W., and Jeffries, D. H., The Toxicity of Zinc or Cadmium for Chinook Salmon. 1964. Oregon Fish Comm. Briefs 8, 1.

[Table 1]. High concentrations of chromium, lead, zinc, copper and cadmium were found also in sediments at Station 62 near the Potrero Power Plant discharge; high metals concentrations at Station 62 were not attributed to the Southeast Plant discharge. Cadmium, copper and mercury concentrations were generally highest near the Islais Creek mouth or the diffuser; however, the distributional pattern of these metals was irregular.

Table 1

HEAVY METAL CONCENTRATIONS
SOUTHEAST PLANT EFFLUENT AND SAN FRANCISCO BAY
September 1975

Station Number	Station Description	Date	Metal					
			Pb	Zn	Cu	Cd	Cr	Hg
	Effluent (mg/l)							
1	Southeast Plant Effluent at Booster Pump	8-13	<0.05	0.090	0.06	<0.003	0.07	
		8-14	<0.05	0.150	0.07	0.014	0.12	
		8-15	0.06	0.114	0.05	0.010	0.14	
		8-16	0.06	0.160	0.07	0.010	0.08	
	Receiving Water (mg/l)							
3	San Francisco Bay at the end of the Army St. Terminal, Surface (-0.5 m)	8-12	0.03	0.050	0.04	0.009	0.05	
		8-14	0.04	0.047	0.04	0.007	0.07	
		8-16	0.04	0.041	0.04	0.007	0.07	
4	San Francisco Bay at the end of the Army St. Terminal, Depth (-11 m)	8-12	0.03	0.038	0.03	0.004	0.04	
		8-14	0.04	0.040	0.03	0.005	0.04	
		8-16	0.04	0.076	0.03	0.005	0.04	
5	San Francisco Bay, Approx. 200 m from the end of the Army St. terminal Surface (-0.5 m)	8-12	0.03	0.043	0.03	0.005	0.05	
		8-14	0.03	0.043	0.04	0.005	0.05	
		8-16	0.04	0.049	0.04	0.005	0.05	
6	San Francisco Bay, Approx. 200 m from the end of the Army St. Terminal Depth (-9 m)	8-12	0.03	0.100	0.03	0.006	0.04	
		8-14	0.03	0.043	0.03	0.005	0.04	
		8-16	0.03	0.049	0.03	0.005	0.04	
7	San Francisco Bay, Approx. 600 m from the end of the Army St. Terminal, Surface (-0.5 m)	8-12	0.03	0.031	0.03	0.004	0.04	
		8-14	0.03	0.030	0.03	0.004	0.04	
		8-16	0.03	0.030	0.03	0.004	0.04	
8	San Francisco Bay, Approx. 600 m from the end of the Army St. Terminal, Depth (-9 m)	8-12	0.03	0.043	0.03	0.004	0.04	
		8-14	0.03	0.043	0.03	0.004	0.04	
		8-16	0.03	0.043	0.03	0.004	0.04	
9	San Francisco Bay, Approx. 1,000 m from the end of the Army St. Terminal, Surface (-0.5 m)	8-12	0.03	0.023	0.03	0.003	0.03	
		8-14	0.03	0.030	0.03	0.003	0.03	
		8-16	0.03	0.030	0.03	0.003	0.03	
10	San Francisco Bay, Approx. 1,000 m from the end of the Army St. Terminal,	8-12	0.03	0.031	0.03	0.003	0.03	
		8-14	0.03	0.030	0.03	0.003	0.03	
		8-16	0.03	0.030	0.03	0.003	0.03	

Table 1 (Continued)

HEAVY METAL CONCENTRATIONS
SOUTHEAST PLANT EFFLUENT AND SAN FRANCISCO BAY
September 1975

Station Number	Station Description	Date	Metal Pb	Zn	Cu	Cd	Cr	Hg (ug/kg)
			Sediment (mg/kg)					
05	San Francisco Bay, 100 m North of diffuser, 100 m out from Army St. Terminal	9-20	41	110	33	1.12	71	0.35
04	San Francisco Bay, 200 m from the mouth of Islais Creek, 100 m South of diffuser	9-20	43	112	46	1.06	77	<0.25
02	San Francisco Bay, 200 m out from Army St. Terminal, 300 m South of diffuser at buoy 7	9-20	18	68	25	0.94	62	<0.25
03	San Francisco Bay, 500 m out from Army St. Terminal in line with diffuser	9-20	32	84	31	0.92	65	0.31
01	San Francisco Bay, 200 m north of diffuser, 100 m out from Army St. Terminal	9-24	28	77	33	0.84	62	<0.15
24	San Francisco Bay, 200 m north of diffuser, 200 m out from Army St. Terminal	9-24	37	102	41	0.94	81	<0.25
08	San Francisco Bay, 900 m directly out from Potrero Pt. Power Plant discharge	9-24	46	101	49	1.10	83	<0.25
04	San Francisco Bay, 100 m off site near Hunter's Point (1,000 m south of diffuser)	9-24	9	18	44	0.38	37	<0.25